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GLAZING WORKBOOK.

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CALIFORNIA STATE DEPT. OF EDUCATION, SACRAMENTO

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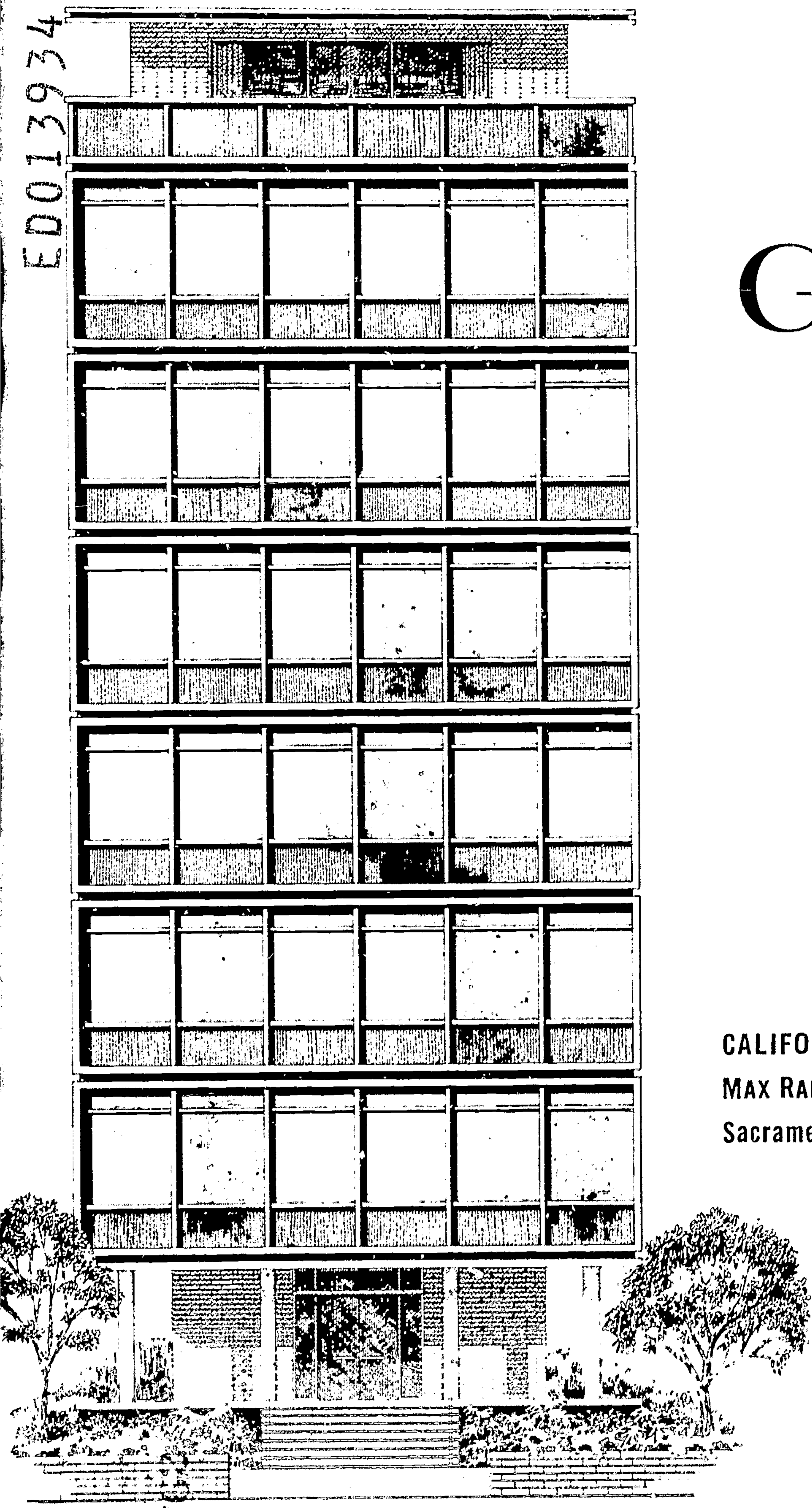
DESCRIPTORS- *STUDY GUIDES, *TRADE AND INDUSTRIAL EDUCATION, *APPRENTICESHIPS, *GLAZIERS, GLASS,

THE TECHNICAL INFORMATION IN THIS STUDY GUIDE WAS PLANNED AND WRITTEN UNDER THE DIRECTION OF THE STATE EDUCATIONAL COMMITTEE FOR THE GLAZING TRADE FOR USE AS RELATED CLASSROOM INSTRUCTION IN THE GLAZING APPRENTICE TRAINING PROGRAM. THE UNITS ARE (1) THE APPRENTICE GLAZIER AND HIS TRADE, (2) BASIC MATHEMATICS, (3) APPLIED MATHEMATICS, (4) BLUEPRINT READING AND SKETCHING, (5) TOOLS AND EQUIPMENT, (6) MATERIALS, (7) GLASS PROCESSING, (8) INSTALLATION, (9) SUSPENDED GLAZING, AND (10) SPECIAL JOBS. TOPIC ASSIGNMENTS WITHIN EACH UNIT HAVE AN INTRODUCTION OF BACKGROUND INFORMATION AND AN OUTLINE OF MAJOR POINTS IN QUESTION FORM, A SECTION OF RELATED INFORMATION, A STUDY ASSIGNMENT FROM SUPPLEMENTARY MATERIALS, A STUDY GUIDE OF EXERCISES TO BE COMPLETED, AND A CHECKUP TEST OF TRUE-FALSE QUESTIONS FOR STUDENT SELF-EVALUATION. A RECORD OF TOPICS COMPLETED MAY BE KEPT IN THE STUDY GUIDE INDEX. THE STUDY OF THIS 144-HOUR COURSE BY INDENTURED APPRENTICES ON A GROUP OR INDIVIDUAL BASIS IS TO BE DIRECTED BY A QUALIFIED JOURNEYMAN OF THE TRADE. THE TOPICS CONTAIN DETAIL CONSTRUCTION DRAWINGS AND PHOTOGRAPHIC AND LINE-DRAWING ILLUSTRATIONS. A GLOSSARY OF TERMS AND A LIST OF REQUIRED AND RECOMMENDED INSTRUCTIONAL MATERIALS SUCH AS REFERENCE BOOKS, CATALOGS, BROCHURES, AND INSTALLATION MANUALS ARE INCLUDED. TESTBOOKS AND FINAL EXAMINATIONS ARE AVAILABLE TO THE INSTRUCTOR. THIS DOCUMENT IS AVAILABLE FOR $3.00 FROM BUREAU OF INDUSTRIAL EDUCATION, CALIFORNIA STATE DEPARTMENT OF EDUCATION, 721 CAPITOL MALL, SACRAMENTO, CALIFORNIA 95814. (HC)



Glazing

Workbook

CALIFORNIA STATE DEPARTMENT OF EDUCATION
MAX RAFFERTY - Superintendent of Public Instruction
Sacramento 1967

Related Training Record

A column labeled "Assignment Date" has been provided at the right-hand side of each page in the Contents. Whenever your instructor assigns a topic, he should write this date in the appropriate blank. When you have completed the topic satisfactorily, your instructor should place his initials next to the assignment date. If this procedure has been followed, and you should transfer from one school to another, you will have an accurate record of the work you have completed. It should never be necessary for you to duplicate work on topics already studied or to skip topics not previously assigned.

In order to provide other school records needed, be sure to fill in below your name, home address, and telephone number. Then ask your instructor to fill in the official date of your enrollment in his class and to sign his name.

NAME____________________________________

ADDRESS________________________________

____________________PHONE____________

DATE ENROLLED___________________________

INSTRUCTOR(S)___________________________

____

Glazing

Workbook

Prepared Under the Direction of the
BUREAU OF INDUSTRIAL EDUCATION

RICHARD S. NELSON
Chief of Bureau

WALLACE THEILMANN
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Foreword

The organization of related training courses for apprentices to supplement their work at the trade is relatively new. These courses are highly specialized, and few commercially prepared training manuals related to course content are available. Accordingly, the California State Department of Education has been given the assignment of developing relevant instructional materials. The Department meets this responsibility primarily through the Bureau of Industrial Education.

We are confident that the apprentices who have chosen to work in this trade, as well as the journeymen who are instructing them, will find participation in the related training course both helpful and stimulating.

Max Rafferty

Superintendent of Public Instruction

Preface

The Bureau of Industrial Education has responsibility for making available to the apprentice related instructional materials required for use in the training programs offered by the various trade groups in the state. The Bureau meets this responsibility by working cooperatively with employer-employee groups representing each of these trades in determining what materials are needed and in developing these materials.

This edition of Glazing was planned under the direction of the State Educational Advisory Committee for the Glazing Trade. The membership of the committee included the following representatives of employers and employees:

Representing the Employers	Representing the Employees
Norman Tyre, Los Angeles	Luther Knight, Los Angeles
Harold O. Swaney, San Francisco	Francis J. O'Connor, San Diego
	Robert Kerr, Oakland

Material for this edition was written by Neil W. Bates, Seal Beach; Julian R. Gallegos, San Gabriel; Luther Knight, Los Angeles; Stanley M. Smith, San Bruno; and Francis J. O'Connor, San Diego.

Special thanks and appreciation are extended to Mr. Harold O. Swaney, who served as Special Consultant to the Department of Education in coordinating the development of this training program, and to Julian R. Gallegos, who reviewed the material in the various stages of preparation for publication and gave valuable assistance in verifying data and supplying needed information.

DONALD E. KITCH
Acting Chief,
Division of Instruction

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Industrial Education

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Contents

Introduction

This information is intended to help you understand why you are required by your apprenticeship agreement to enroll in a course of approved instruction. It will tell you what you are expected to do in the course and what your instructor will do. It will explain how to use the workbook and its accompanying testbook and how to study so that you will remember what you read. You will find that these things are important to your study of the course, and you should therefore read this section carefully before beginning your first assignment. There are no questions covering this information in the accompanying testbook.

The Purpose of the Course

The program of education for modern apprenticeship includes two distinct phases. In the first phase, you learn the skills of the trade on the job; as an apprentice glazier, you work under an experienced journeyman glazier, and you will be paid for your work while you are learning. In the second phase of the program, you attend a class, usually during the evening, in which you study information related to your job. Such technical information is easier to learn in a school than on the job, since much of it is available only in books, manuals, and films that can best be used in a schoolroom with the aid of a teacher. This related information explains the "why" of the trade and is concerned with such things as safety practices, the interpretation of drawings, and the use of tools.

It is necessary for you to realize the importance of the technical information relating to your work. The worker who understands this side of his craft is better able to plan work, to understand the plans of others, and to solve immediate craft problems. A glazier can sometimes keep on working with only a small understanding of his trade, but such a worker rarely becomes a really successful journeyman, a foreman, or a superintendent. The knowledge you can obtain through regular school attendance and careful study of the assignments in this course will prepare you for advancement in the glazing trade.

This course has been designed to make it as easy as possible for you to acquire knowledge about your trade. The information is organized systematically, and frequent checks are offered to test your understanding of the material.

Workbook Assignments

The workbook is a guide to the material you will study in class. Assignments to certain reference books will be made in most of the topics of the workbook. You will be told what pages to read in the reference books, what blueprints to consult, and what problems to solve in order to obtain the fundamental technical

knowledge you will need. Occasionally there will be a topic for which no adequate reference materials could be found; in such a topic, the background information has been included in the workbook.

You will be required to purchase all of the technical books that are assigned in the workbook topics. These are books used repeatedly throughout the course. You will find them helpful to have as your own personal property, both during the course and later on as you encounter problems on the job. Other publications will be used less frequently; these may be found in your classroom library. Books and other instructional materials needed in your study of this course are listed under the heading "Instructional Materials" in the back of this workbook.

As you work on your study assignments, you may encounter ideas that you do not fully understand. Your teacher, who has earned his living at the trade, will help you with such problems. Most of the time he will be working with small groups or with individuals, trying to divide his time equally among them. When he is working with others, you can make progress on your own by following the instructions in your workbook. Remember that your teacher cannot learn your assignments for you; the effort to learn will have to come from you, yourself.

The teacher will do his best to assign topics that relate to the work you are doing on the job. However, it will not always be possible to match your work with your study in class. You should keep in mind that all of the topics contain information that will be valuable to you at some time in your work.

Your instructor will probably make your assignments by writing the date in the column provided for that purpose in the "Contents" pages at the front of your workbook. When you have finished the assignment, he will probably initial it in the same place.

Supplementary Materials

Reading is only one method of learning. When you are learning about certain operations, your instructor will perform demonstrations to help you to understand the processes involved. Once in a while he may arrange for a field trip to a shop or to a construction project at the time that various types of glass are being installed. He may use charts and drawings to explain the techniques used in present-day glazing, and occasionally he will conduct group discussions on questions you may not have understood fully. You may be asked to be prepared to discuss one or more assigned topics relating to the material being studied.

Study Guide and Test

Exercises and test questions are included in each topic in the workbook to enable you to check your knowledge after you have studied the assignment. If you cannot answer one of these questions, you will find the needed information in the workbook or in one of the assigned reference books. Look the answers up yourself; you will find that you remember them better that way.

Testbook

When you have finished studying an assignment and feel that you have mastered it, the teacher will test you on it. The tests he uses are in a testbook that he keeps in his files; these tests enable you and your teacher to find out how well you have learned what you were studying. He will grade the test after you have completed it. The results of the test will reveal those parts of the assignment in which you may need further help, and the teacher will discuss those parts with you. He may require you to do all or part of the assignment again if he feels this is necessary. When you have completed the test satisfactorily, the teacher will give you a new assignment.

Give your classroom work the attention it deserves. Keep in mind that if you keep failing the tests in the course, you will be asked to appear before the local joint apprenticeship committee to show why you should not be released from your apprenticeship agreement.

Progress Records

In your study of this course, you may progress as fast as your ability allows you to. Because the course consists of a series of individual study assignments, you and your classmates may all be working on different topics at any given time. For this reason, your instructor will probably use a chart to keep an accurate record of your progress. This progress chart indicates, for each apprentice, the assignment he is working on and the assignments he has already completed.

It is important that you keep a record of your work processes on the job. Every apprentice agreement specifies that the apprentice spend a certain number of hours on each kind of work on the job; this is to ensure that when his apprenticeship is completed, he will be a skilled all-around craftsman. It is your responsibility to make sure that this agreement is followed. Your employer will probably be too busy to keep a work process record for you, but in most cases he will be willing to see that you get a well-rounded training as a glazier if you keep such a record accurately and remind him when the time for a new assignment is at hand.

Another reason for keeping up your records is that the joint apprenticeship committee must have specific information about your job experience before it can authorize your periodic pay increases. Also, your record must be complete before the committee can recommend that you be awarded journeyman status. Both job and school records are of great importance to your progress as an apprentice. You will be wise to take the time necessary to keep them up to date.

How to Study Efficiently

It is unlikely that you will have enough time to do all the work of the course in the classroom; you will probably have to study at home as well if you are to finish the course on time. It will be a great help to you in your work if you can finish this course in the shortest time that will permit thorough studying. The best way to accomplish this is by outside study.

Did you ever wonder why some things are easily remembered and others are quickly forgotten? If you think about it, you will usually find that you have had reason to talk about and review the things you remember, or that you have a special interest in those things. The following method of reading technical information will work if you give it a chance:

1. Skim through the entire assignment, reading paragraph headings and topic sentences. Get the overall picture of what the assignment is about.

2. Go back to the beginning of the assignment and read the first paragraph; then look up from the book and see if you can repeat to yourself, in your own words, the meaning of the paragraph. If you cannot do this, the information did not "soak in" and you will have to go over it again until it does. You cannot avoid the fact that if you did not understand what you read, you will not be able to remember and use it at some future time.

3. Repeat this process with each paragraph in the assignment. As you study, try to relate the material you are reading to your work experience.

4. If possible, talk the assignment over with someone to reinforce your memory and clarify your ideas.

Although this method of study requires a little more time at first, you will soon find that you can work as rapidly as before and that you will retain more information than you ever did with less systematic methods. The ability to read fast and accurately is an important advantage if you want to progress as a glazier. Such ability will enable you to finish this course in less time and with more lasting results, and it will help you keep up to date in your assigned classwork.

UNIT A The Apprentice Glazier and His Trade

TOPIC 1--THE APPRENTICESHIP SYSTEM

This topic, "The Apprenticeship System," is planned to help you find answers to the following questions:

- What are the origins of the apprenticeship system?
- How has modern apprenticeship developed from the guild system of the Middle Ages?
- How is apprentice training regulated in California?
- What contributions do labor and management organizations make to the training of the apprentice glazier?

Apprenticeship as a system for training new workers in the skilled trades has been in use since the dawn of history and has withstood the test of time. Various other training systems have been tried, but in general they have not been successful. The apprentice learns by doing--by practicing his trade under the instruction of a journeyman. Training on the job is essential to the development of skilled tradesmen, and apprenticeship has proved to be the best means of providing and regulating such training.

Apprenticeship in the Guilds

A written code regulating apprenticeship existed as early as 2100 B. C., but very early records of the operation of the apprenticeship system are unclear and incomplete. The system began to flourish in the early part of the twelfth century with the emergence of the craft guilds, which were trade associations whose membership consisted of the masters, journeymen, and apprentices of each occupation. The craft guilds became very powerful in the Middle Ages; the right to work at a trade depended upon membership in the guild, and guild membership often carried with it the privileges of citizenship.

The system of basing apprenticeship upon a written agreement--an indenture--was originated by the guilds. The relationship between master and apprentice was much like that between father and son, the master's authority extending to every aspect of the apprentice's life. The master was responsible for providing the apprentice with food, clothing, housing, and the tools of the trade; for instructing him in his craft; and for teaching him ethics, morals, and religion.

After a period of time--usually four years--the apprentice received his first pay, and thereafter he provided his own support. Still later, his pay was increased so that he could both support himself and furnish his own tools. When

his training was completed, the apprentice was given an examination; if he passed, he became a journeyman (or day worker, in the original meaning of the term). When he was able to pay the required fees and set up his own establishment, he himself could become a master. Apprenticeship in all its aspects was closely supervised by the guild, and consequently the system provided very thorough and effective training.

Apprentice training provided the chief means of trade education until about the middle of the eighteenth century, the time of the Industrial Revolution. Then, the changeover from handicraft to factory production methods doomed the guilds and forced the traditional system of apprenticeship into rapid decline.

Apprenticeship in Colonial America

In early colonial times, America's supply of skilled workers came for the most part from Europe; the young country at first had no organized method of trade education. As America grew and as its society became more complex, colonial tradesmen organized their occupations and established apprenticeship systems. Colonial apprenticeship resembled that of the guilds of the Middle Ages, although it was not as closely supervised.

Apprenticeship and the Industrial Revolution

As the factory system developed, abuses in the apprenticeship system became prevalent. The protection for the apprentice that had been provided by the guilds was gone, and the system developed into a form of industrial slavery for the young. Frequently an apprentice was required to perform all manner of tasks that had no bearing on his trade training, and his period of apprenticeship was often much longer than would actually have been necessary for learning the trade. By 1860, the Industrial Revolution had eliminated the old type of apprenticeship, and America entered the period of industrial expansion of the 1870s and 1880s with no effective program of industrial education.

Apprenticeship declined with the growth of the factory system for many reasons. With the development of machinery, fewer skilled workers were needed. Many employers considered it unprofitable to train apprentices. After the training period was over, the new journeyman often found work with another employer who had not bothered to train his own apprentices. Workmen themselves often did not approve of the apprenticeship system and sometimes tried to prevent the apprentice from learning the trade. Apprentices were in general poorly paid; workers in unskilled jobs were often paid much better. Also, many boys hesitated to enter manual trades because such work meant soiled hands and rough clothes.

Substitutes for Apprentice Training

With the decline of the old type of apprenticeship, many substitute methods of trade education were tried, but none succeeded. Occupational training schools--private institutions, for the most part--did not fill the need; they failed because of the opposition of labor groups, whose members sometimes

felt that such training schools would overcrowd the trade, and because they were training too few men to keep the ranks of skilled workers filled. All of these training schools were subject to the same handicap: school training alone, without training on the job, is inadequate preparation for success in the trades. On-the-job factors such as pay, production speed, commercial standards of workmanship, and the possibility of layoffs create mental attitudes toward learning that cannot be produced by the school environment alone.

The Revival of Apprentice Training

By the early part of the twentieth century, it was evident that an effectively organized system of trade education was needed in America. Some of the more active trade groups in the country worked to improve trade education, but their efforts did not provide a broad enough solution to the problem. The federal government acted to encourage these efforts with the establishment, in 1934, of the Federal Committee on Apprenticeship and the Apprentice-Training Service. The Fitzgerald Act of 1937 made the Apprentice-Training Service (today known as the Bureau of Apprenticeship and Training) a permanent agency of the Department of Labor.

The Federal Committee on Apprenticeship is now made up of five representatives of employers, five representatives of labor, and a representative of the U. S. Office of Education. The committee's functions are:

- To promote a better national understanding of apprenticeship standards and to develop and recommend minimum standards of apprenticeship for various trades.
- To act in a technical, consulting, and advisory capacity in support of all agencies concerned with labor standards for apprenticeship.
- To cooperate with state apprenticeship councils and with local trade-apprenticeship committees.
- To act as a control agency for the collection and distribution of information on methods and procedures useful in promoting labor standards for apprenticeship.

Apprentice Training in California

Although the establishment of national agencies contributed greatly to the rebirth of apprenticeship in America, the details of apprentice training programs have been determined on the local and state levels. The passage of the Shelley-Maloney Apprentice Labor Standards Act of 1939 established the legal basis for the development of organized apprentice training programs in California. According to the provisions of this law, the Governor appoints the members of the California Apprenticeship Council, which is composed of the following: six representatives of industry and six of labor; two representatives of the general public; the Director of Industrial Relations; and the Chief of the Bureau of Industrial Education. The Apprenticeship Council promotes and develops apprenticeship throughout the state and establishes standards for minimum wages, maximum hours, and working conditions for apprenticeship agreements.

An apprentice is defined by the Shelley-Maloney Act as a person at least 16 years old who has entered into a written apprenticeship agreement with an employer or his agent. This agreement must provide for not less than 2,000 hours of reasonably continuous employment for the apprentice, as well as for his participation in an approved program of training in related and supplemental subjects.

The Shelley-Maloney Act named the Director of Industrial Relations as the Administrator of Apprenticeship and established the Division of Apprenticeship Standards to assist him in his duties. This office does the detail work necessary to ensure that all apprenticeship agreements conform to the standards established by law and by the policies of the Apprenticeship Council.

Apprenticeship arrangements are handled by committees representing the local employee and employer organizations. In the glazing trade, representatives of local unions and employers' associations form local joint apprenticeship committees, which have the responsibility of supervising and enforcing the individual apprenticeship agreements. The authority of the joint apprenticeship committee is stated in a written agreement (usually called the Apprenticeship Standards Agreement) between employee and employer groups. The standards agreement usually covers the selection, rating, registration, promotion, and discipline of apprentices; the enforcement of individual apprenticeship agreements; the determination of wages for apprentices; and the supervision of job training. The joint apprenticeship committee works to encourage the public's interest in, and support of, the apprentice training program and may at times be called upon by local boards of education to advise school personnel in the details of class organization for trade instruction and to assist in the qualification and selection of instructors for apprentices.

The Apprentice Glazier

In the course of his four-year apprenticeship, the apprentice glazier will receive instruction in the many phases of the flat-glass industry, and he will learn to perform the many tasks that are related to his trade. This training will help him to achieve the goal of becoming a skilled craftsman in the glazing trade. A skilled glazier will be called upon to undertake a wide variety of glass installation jobs. Such jobs include new work and replacement work in residential jobs and large commercial jobs; work involving standard glazing techniques and materials; and work that requires the use of new techniques and the ever-increasing variety of new materials relating to the glazing trade.

When his apprenticeship has been completed and he has advanced to become a journeyman, the glazier should be able to do any type of glazing job in the shop or in the field correctly and efficiently. As a bona fide glazing journeyman in the flat-glass industry, he will work under the wage scale of a journeyman. As time passes and his skill is recognized, he may become a leadman or foreman, and he may begin training other apprentices who will be coming into the trade.

Labor Unions, Management Associations, and the Apprentice Glazier

The union glassworkers in California are affiliated with the Brotherhood of Painters, Decorators, and Paperhangers of America. At the present time there are seven glaziers local unions in California. In some of the outlying areas of the state, where there are not enough glaziers to warrant a local of their own, the glaziers affiliate with what is called a "mixed local," which means that they are in the same local with the painters.

One basic function of the glaziers union is to negotiate with employers, through the process of collective bargaining, to obtain for its members improved working conditions, better wages, and such fringe benefits as health and welfare plans, pensions, vacations, and holidays. Another is to make sure that both the employer and the employee abide by the current working agreement. The glaziers unions in California have also negotiated apprentice trust funds to improve the training program for the apprentice glazier, with the aim of providing the glazing industry with top-notch craftsmen.

There are three Regional Conferences of Glaziers and Glassworkers in the United States: the Western States Conference, the Middle States Conference, and the Eastern States Conference. The three regional conferences make up the National Conference of Glaziers and Glassworkers of the United States and Canada. The regional conferences meet twice a year; the national conference meets once a year. Each local union elects delegates from its membership to represent the local at these conferences.

For the past few years, the employers of the union-membered glazing shops have formed organizations known as glass management groups. These employer organizations meet with the unions within their jurisdictional areas to solve problems of mutual concern before these problems get out of hand. Members of the employer organizations, together with representatives of labor, set up trust funds for apprenticeship, for health and welfare, and for pensions, and form such labor-management bodies as joint apprenticeship committees and labor negotiation committees. The labor negotiation committee negotiates a single contract to apply in the area of jurisdiction of a single union, to ensure that there will not be different contracts for the various shops within the area. When the contract has been ratified, it is binding upon all members of the participating glass management group.

The glazing industry in California has made significant progress in its apprenticeship program since the adoption of the Shelley-Maloney Act. This progress in apprentice training has come about not by chance, but through the combined efforts of industry and organized labor, both of which can be expected to continue their work to develop a better and more effective apprenticeship program for the mutual benefit of the apprentice glazier and the glazing industry.

Topics for Discussion

Be prepared to discuss the following topics if you are asked to do so:

1. The functions of a local joint apprenticeship committee
2. The significant differences between apprenticeship in the Middle Ages and apprenticeship today
3. The decline of guild apprenticeship and the development of modern apprenticeship
4. The part played by local unions and employers' organizations in the training program for the apprentice glazier

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 1--THE APPRENTICE SYSTEM - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in the exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. One difference between modern apprenticeship and guild apprenticeship is that today's apprentice receives __1__ in addition to his instruction.	1. ________
2. The apprentice learns by practicing his trade under the instruction of a __2__.	2. ________
3. A written code regulating apprenticeship existed as early as __3__ B. C.	3. ________
4. Under the guild system, apprenticeship was based on a written agreement called an __4__.	4. ________
5. Guild apprenticeship was forced into decline by the __5__ __6__.	5. ________ 6. ________
6. As the factory system developed, many employers found it unprofitable to train __7__.	7. ________
7. Occupational training schools were unsuccessful as alternatives to apprenticeship because they failed to train enough __8__ __9__.	8. ________ 9. ________
8. The Bureau of Apprenticeship and Training is an agency of the __10__ of __11__.	10. ________ 11. ________
9. Apprentice __12__ __13__ have been negotiated by the glaziers unions to improve the apprentice-training program.	12. ________ 13. ________
10. Local joint apprenticeship committees are made up of representatives from employers' associations and __14__ __15__.	14. ________ 15. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Apprenticeship has been employed for craft education for at least 4,000 years.	1.	T	F
2. An apprentice under the guild system was bound by an indenture.	2.	T	F
3. The original meaning of the term "journeyman" was a day worker.	3.	T	F
4. The Industrial Revolution increased the influence of the craft guilds.	4.	T	F
5. Apprentice training was the source of most of America's skilled workers in early colonial times.	5.	T	F
6. The Shelley-Maloney Act established basic standards for apprentice labor in California.	6.	T	F
7. The local joint apprenticeship committee has the authority to discipline the apprentice.	7.	T	F
8. In some outlying areas of California, glaziers affiliate with carpenters to form "mixed locals."	8.	T	F
9. Unions negotiate benefits for their members through collective bargaining.	9.	T	F
10. The regional conferences of glaziers and glassworkers meet once a year.	10.	T	F

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 2--THE HISTORY OF GLAZING

This topic, "The History of Glazing," is planned to help you find answers to the following questions:

- How did early glassmakers produce glass and make ornamental and useful glass products?
- When and where did glassmaking originate in America, and how did the industry develop?
- How is modern flat glass produced?

The Early History of Glass

The exact location and date of the first manufacture of glass are not known, but evidence has been found that glass was manufactured in Egypt as early as 3400 B.C., and excavations indicate that glass may have been manufactured in Mesopotamia in 2450 B.C. The first glasses were made from quartz sand, natural lime, and soda, which were readily available in the desert. Early workers in glass fused these materials at comparatively low temperatures. Glassblowing, an invention that has been attributed to the Phoenicians, was developed to a fine art by the Egyptians, who produced colored glass and laid exquisite glass mosaics.

Egypt was the center of the glassmaking craft for many centuries before the birth of Christ. From Egypt, glass was carried to the entire Mediterranean area by Phoenician traders. Colored opaque glass was used by the Athenians for decoration, and glass was manufactured in all of the countries of the Roman Empire. Spanish glassmaking can be traced from the time of Christ.

Historical accounts indicate that stained-glass windows were in use in churches in the fourth and fifth centuries A.D. Pictorial designs were being applied to such windows by the twelfth century. The first colored glass was produced by adding metallic oxides to the glass batch during melting, a method that is still in use today. The fusing of enamel to the glass surface was a later technique used by stained-glass artisans.

The Romans, who produced a great variety of both ornamental and utilitarian glass objects, probably made the first relatively clear glass windows, which were small panes about one-half inch thick. The use of glass for windows, however, remained very limited until about the seventh century A.D., when new production techniques, including the use of the blowpipe, simplified the manufacture and improved the quality of early flat glass. The glass window was considered a luxury for many centuries after its introduction. Principally because of their high cost and the high taxes levied on them, early glass windows were installed mainly in churches and castles. A tax on glass windows was still being levied in England in the middle of the nineteenth century.

Following the period of the Crusades, many small glass factories, employing thousands of artisans, grew up in Venice. Venetian glassmakers were incorporated in 1268, and an elaborate guild system developed. In 1291, glassmaking operations in Venice were relocated to the neighboring island of Murano to reduce fire hazards and to safeguard the secrets of the trade, but the pirating of skilled glassworkers by other communities and nations ultimately reduced the importance of Venice as a center of glassmaking. However, the influence of Venetian glassmakers on the growing craft was still great in the period of the early Renaissance, which can be considered to mark the beginning of the era of modern glassmaking. By the early seventeenth century, the art of the European glassmaker had become sufficiently advanced to make possible the production of glass for microscopes, telescopes, and other early scientific apparatus.

Glassmaking in America

The first American glass plant was established in what is now Jamestown, Virginia, in 1609. This glass factory, like the few others that operated for brief periods in early colonial America, produced crude bottles, bowls, and window panes, and made beads and other glass trinkets for use in trading with the Indians. The first American glassworks to achieve even a moderately long period of success was that of Caspar Wistar, a Philadelphia button maker. Wistar's plant, employing European glass workers and using European equipment, was established in 1739. This plant, like that of its later competitor Henry Stiegel, passed out of existence during the Revolutionary period. After the American Revolution, glass plants were established in New York, in Pennsylvania, and in the New England area. Toward the end of the eighteenth century, three glassworks were in operation in Pittsburgh. Largely because of its accessible supply of sand and coal, this city had become the major American glass center by 1850.

The development of the American glass industry proceeded slowly in the first half of the nineteenth century. The glass industry, like other industrial enterprises of the period, was handicapped by an inadequate supply of trained workmen and heavy competition from foreign manufacturers. By 1800 there were about 170 operating glassworks in America; about one-fourth of these were producing window glass, employing techniques essentially like those of earlier centuries. Flat glass was produced by flattening hand-blown cylinders and bubbles, or by spinning a molten glass ball on the end of an iron rod to form a thin disk which, when cooled, was cut into small lights. By 1865, many new developments had improved glassmaking in America, but hand methods dominated the flat-glass industry until the early part of the twentieth century.

In 1903, a mechanical method of producing large glass cylinders for the manufacture of flat glass was developed, and ten years later the Belgian Fourcault designed a machine to draw a flat glass sheet vertically over rollers directly from a vat of molten glass. Variations and improvements of the latter method are used today to produce sheet glass of excellent commercial quality.

The production of ground and polished glass, or plate glass, like that of sheet glass, was handicapped by a lack of economical production techniques in the American glass industry until the early years of the twentieth century. Until the early 1920s, plate glass was produced entirely by the casting process, both in the United States and elsewhere. The glass was melted in pot furnaces, each holding as many as 20 pots. When the melted glass was ready for casting, a pot was removed from the furnace, skimmed, and its contents were poured over a flat, cast-iron table, which was covered with fine sand to prevent the glass from sticking and chilling. A cast-iron roller was passed over the poured glass to form the unfinished plate, which was subsequently annealed and then ground and polished, by hand in earlier methods, and on large mechanical grinding and polishing tables in later methods.

The production of flat glass, including quality plate glass, is accomplished with high-volume automatic production machinery in modern American glass plants. Raw materials are mixed at one end of the production line, and a continuous output of finished and cut-to-size glass is obtained at the other end of the line. Even the packaging of glass for storage and shipment is accomplished with automatic machinery in modern plants.

American glass manufacturers have in recent years produced many new products that have multiplied the uses of glass and challenged the skill of the glazier. Among these are laminated safety glass, thermal-insulating and heat-absorbing glass, and heat-treated tempered glass. The industry will continue to produce new and improved flat-glass materials, and the glazier's art will advance to accommodate these developments as they appear.

Topics for Discussion

Be prepared to discuss the following topics if you are asked to do so:

1. Modern production methods for flat glass
2. Recent product developments in the flat-glass industry

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 2--THE HISTORY OF GLAZING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The exact location of the first ancient glassworks is __1__ __2__.	1. ________ 2. ________
2. For many centuries before Christ, the center of the glassmaking craft was __3__.	3. ________
3. The use of glass for windows was very limited until about the __4__ century A. D.	4. ________
4. Taxes on glass windows were levied as late as the __5__ century.	5. ________
5. In the period of the early Renaissance, many skilled glassworkers came from __6__.	6. ________
6. The first American glass plant was established in __7__, Virginia, in the year __8__.	7. ________ 8. ________
7. Toward the end of the eighteenth century, __9__ glassworks were in operation in Pittsburgh.	9. ________
8. Nineteenth-century American glassworks produced flat glass from hand-blown __10__ and __11__.	10. ________ 11. ________
9. A Belgian named __12__ designed a sheet-glass production machine in the early part of this century.	12. ________
10. Modern flat-glass production is accomplished with high-volume __13__ production __14__.	13. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The first glass was made by fusing quartz sand at high temperature.	1.	T	F
2. Glass was manufactured in all the countries of the Roman Empire.	2.	T	F
3. Stained-glass windows were in use in churches as early as the fourth century A. D.	3.	T	F
4. The Venetian glassmaking guild system developed in the fifteenth century.	4.	T	F
5. Glass for scientific instruments was being produced in the seventeenth century.	5.	T	F
6. Henry Stiegel operated the first successful glass-works in America.	6.	T	F
7. After the American Revolution, glass plants were established in New York, Pennsylvania, and the New England area.	7.	T	F
8. By 1800 there were about 170 operating glassworks in America.	8.	T	F
9. Hand methods dominated the American flat-glass industry until the early part of the twentieth century.	9.	T	F
10. The casting method was used for the production of plate glass until about 1800.	10.	T	F

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 3--SAFE WORKING PRACTICES

This topic, "Safe Working Practices," is planned to help you find answers to the following questions:

- What are the principal causes of industrial accidents?
- What are the safe working practices that the glazier must observe to avoid accidents and injury on the job?
- How does the State of California establish standards and enforce regulations pertaining to the safety of workmen?

Both the employer and the worker contribute a part in the prevention of on-the-job accidents and injuries. It is the responsibility of the employer to provide safe working conditions, including the proper maintenance of all equipment; the worker, on the other hand, must know and observe the general rules of industrial safety and accident prevention, as well as the particular safety rules and precautions that relate to his trade. Recommended safety practices will be given throughout this course in topics where they are specifically appropriate; a general discussion of industrial safety and safe working practices in the glazing industry will be the concern of this topic.

Accidents and Their Causes

An accident can be defined as an unplanned and unforeseen event that interrupts the orderly progress of an activity. Accidents usually result in damage to or loss of equipment and material, and all too often they result in painful, costly, and disabling injury. In 1965 in the United States, more than 14,000 workers lost their lives as a result of on-the-job accidents. Every accident should be analyzed to determine why and how it happened, and steps should be taken to ensure that similar accidents will not happen in the future. This process is an essential part of accident prevention.

Industrial accidents are caused by unsafe working conditions, unsafe acts, or some combination of these two hazards. Unsafe conditions go hand in hand with equipment that is poorly designed and constructed, improperly installed, or badly maintained. Makeshift scaffolds, unguarded power tools, poor housekeeping, and inadequate lighting are common factors in accidents. Unsafe acts are violations of safe working practices--for example, wearing loose clothing when operating power saws and similar power tools; operating machinery without guards where these are required; throwing materials and tools instead of carrying them; and lifting or carrying with the back bent.

Unsafe conditions and unsafe acts are each threats to the worker's safety, but it is usually a combination of these hazards that causes industrial accidents. A wheelbarrow with cracked or loose handles (an unsafe condition)

may not figure in an accident until someone attempts to wheel a heavy, poorly balanced load in it (an unsafe act).

Accident-prevention programs maintained by employers typically include group safety meetings, individual safety instructions, and the work of safety committees. The apprentice should actively support and participate in such programs; he owes it to himself, to his family, and to his employer to learn the rules of safety and to observe them faithfully.

Accident Prevention

Glaziers are exposed to a variety of hazards in the course of their work. A glazier must know and respect the hazards of his trade, but he need not fear them; accidents and injury can be prevented if safe working practices are always followed.

Work clothing and protective equipment. The glazier should wear clothing appropriate for the job, and he should use protective equipment in hazardous operations. Ties, garments with loose-fitting sleeves or open cuffs, wristwatches, and rings should not be worn in the vicinity of power machines or when operating portable power tools. Shoes with worn soles offer little protection against nails and other sharp objects. Pants or overalls with torn, bulky, or turned-up cuffs are dangerous because they tend to catch on projections and cause falls. Goggles must be worn if the glazier is working in the vicinity of a grinding or chipping operation; respirators must be worn when they are called for; and hard hats must be worn when construction is going on overhead.

Hand tools. A poorly maintained hand tool is dangerous. A mushroomed head on a chisel or a hammer is very likely to chip on impact, and the flying chip may cause serious injury. Dull tools slip--they do not cut. Over-tempered tools are brittle and are easily broken. Loose hammer heads fly off their handles unexpectedly in use.

Powder-actuated tools. Powder-actuated tools should be handled with the respect normally accorded to firearms. The stud is like a bullet, and it may in fact cause more serious injury than a bullet. Powder-actuated tools must be operated only by persons trained in their use and by persons whose competency has been verified by examination. Operators of these tools must be persons at least twenty-one years old or apprentices in the final six-month period of their apprenticeship. The safe operation of powder-actuated tools is discussed in detail in Unit E of this course.

Power tools and equipment. Glaziers are frequently required to operate electrical tools and equipment. Electrical shock is always dangerous in itself and is sometimes fatal, but even a relatively mild shock from a defective, incorrectly grounded portable electric tool can cause the worker to lose his footing and suffer injury from a resulting fall. The following precautions should be observed when working with electrical tools and equipment:

1. The equipment should be checked to make certain that it is not electrically defective. Portable tools should be tested periodically in the shop to ensure that electrical leakage to the case or frame is negligible.

2. Electrical tools should be checked to make sure that they are properly grounded. Portable tools employ three-conductor power cords; the third conductor is provided for grounding the tool. The grounding wire or the grounding pin should not be cut off on the plug end of the cord. Only heavy-duty, three-conductor extension cords should be used when additional cord length is needed. The tool should be connected only to a receptacle that is provided with an additional contact for grounding the third conductor of the cord. Power cords and extension cords must be in good condition, with no damaged fittings or worn insulation. Cords should not be hung or bent over nails or sharp objects, nor should cords be laid on wet surfaces (such as wet cement). Cords should be protected from being run over by trucks and other construction equipment.

3. Hands must be kept dry when handling electrical equipment, especially portable power tools. If it is necessary to work on a wet surface, rubber-soled shoes and rubber gloves should be worn. (These must be in good condition, with no holes or breaks in the protective rubber material.)

4. A person or piece of equipment in contact with a live power line should never be touched. First, the power on the line should be shut off, then a dry rope should be used to pull the injured person free. First aid should be given and a doctor called immediately.

Power tools and machines that are provided with guards--power saws, for example-- must have these guards in place for safe operation. A power tool or machine should never be used unless instruction in its proper use has been given.

Working at heights. Special safety precautions must be observed in working at heights:

1. When working from a scaffold, the worker must make sure the scaffold meets the safety requirements given in the Construction Safety Orders. (See the study assignment at the end of this topic.)

2. The working areas on the scaffold must be kept uncluttered; this will help ensure the worker's safe movement from point to point.

3. Special care should be used in handling planks when a wind is blowing: the edge of the plank should be kept to the wind and a very firm footing maintained. Large pieces of glass should not be handled on a scaffold or on the ground, if windy conditions prevail.

4. Both hands should never be used in a hard pull to tighten a rope or wire or loosen a board; these may come loose suddenly and cause a bad fall.

5. Guard rails should be provided in all jobs that are to be done at heights over 10 feet.

6. A safety belt should be worn in places where no safe working platform can be erected or installed.

7. Nothing should be thrown down without first checking to ensure that there is no one below, and then only after calling out the warning: "Look out below!" Whenever possible, material should be lowered by rope or hoist.

8. If subject to dizziness or a great fear of falling, a worker should not try to work at heights. The problem should be discussed openly with the foreman.

<u>Handling and transporting glass.</u> Special techniques and procedures must be employed if glass is to be handled and transported with safety. Observe the following precautions when handling large cases of glass:

1. Hoists and similar mechanical devices, not manpower, should be used for handling the cases.

2. Before an electric hoist is used, the glazier should learn how to operate it. It should be checked to ensure adequate lifting capacity for the intended load and to ensure that both slings are securely located on the case of glass. Fingers should be kept out of the way when tightening the slings.

3. Cases should be stacked carefully, ensuring that they have adequate support. When a case is removed from a stack, the workman should make sure that cases in adjacent stacks remain well supported.

4. The glazier should watch out for other workers in the area.

5. If cases or large pieces of glass start to fall, the glazier should get out of the way.

The following rules should be observed when handling single pieces of glass:

1. The glazier should plan ahead. He should know what he is going to do and how he is going to do it before he begins to handle the glass. All the men in the crew should be informed on work plans so they can work together effectively and safely.

2. Hand grip pads should be used to avoid cutting the hands, and web carrying straps should be used for the larger pieces of glass.

3. Glass should always be carried in the vertical position. The pieces should not be "cartwheeled."

4. The glass should never be leaned at an angle great enough to cause it to bend.

5. The glazier should stand close to the work table when placing glass on it or removing glass from it.

6. When glass is being handled in the field, the glazier should never work from a single-horse scaffold, but should use two horses with strong planks laid across them. The horses should be in good condition and should be placed on firm ground or have other solid support.

7. The glazier should avoid carrying glass up or down a ladder but should either pass it from one man to another or use a hoist.

8. Working on wet, slippery surfaces should be avoided.

9. Broken glass should not be removed from a broken window with bare hands. A suction cup or pliers should be used, working from the top down. Goggles should be worn when nipping glass overhead.

When glass is being transported by truck, the following precautions should be taken:

1. The truck should be inspected to ensure that it is in good mechanical order. Special attention should be given to the brakes, tires, lights, and turn signals.

2. The load should be blocked securely to prevent it from shifting. The cases or loose pieces of glass should be anchored at both top and bottom. Glass should be secured to racks with tie-down sticks rather than loose rope.

3. The glazier should drive carefully and obey traffic laws.

Guards and barricades. There are generally a number of carefully guarded or barricaded areas on any construction site--elevator shafts, stairwells, excavations, and floor openings, for example. Such danger spots should be kept in mind on the job and should be reported immediately to the responsible person if they are incorrectly guarded. The public must be protected from these and other hazards of construction. In this regard, construction materials should be removed from streets and sidewalks as soon as possible. Power equipment should be disconnected when it is not in use; and ladders should be taken down at the end of the work day.

Construction elevators and hoists. Unless a construction elevator or hoist is designed and approved for carrying men as well as materials, it should be used only for carrying materials.

Trucks in the work area. The glazier must be on the alert for heavy trucks backing into the area in which he may be working. Heavy trucks for hauling dirt and construction material often have automatic backup-warning devices, but the truck's warning signals may not be heard because of the noise of nearby construction activities.

Good housekeeping. Work areas must be kept clear of debris and other obstacles that might cause workmen to stumble or fall; this precaution is doubly important in areas where glass is in place or is being stored or handled. Tools and materials strewn about work areas are frequent causes of accidents. Materials should be piled neatly and away from passageways, electrical outlets, and work areas. Glass materials should not be left overhanging the edges of work tables or projecting from storage racks. Protruding nails should be removed from materials as soon as possible.

Treatment of injuries. Injuries, however slight, must be reported and treated promptly. Small cuts or abrasions may seem of little consequence; but if untreated and allowed to become infected, they can be as serious as major injuries.

Safety agencies and organizations. A number of public agencies and private organizations are concerned with on-the-job safety. Among these are unions, employer groups, insurance companies, and the California State Department of Industrial Relations, which acts through the Division of Industrial Safety to prepare standards for job safety, investigate serious accidents, and enforce safety laws. From a practical point of view, however, the worker himself has the basic responsibility for his safety and well-being on the job.

Study Assignment

Construction Safety Orders. Sacramento: California State Department of Industrial Relations, Division of Industrial Safety, 1965. Read the following sections:

1. 1509-1523 (General Safety Regulations)
2. 1604-1607 (Construction Elevators)
3. 1610-1618 (Hoisting)
4. 1620, 1621 (Railings)
5. 1625-1627 (Ramps and Runways)
6. 1630, 1631 (Stairwells and Stairs)
7. 1632, 1633 (Floor, Roof, and Wall Openings)
8. 1637, 1640, 1647 (Scaffolds)
9. 1675-1678 (Ladders)
10. Appendix A (Labor Code Excerpts)
11. Appendix B (Handy Construction Data)

Topics for Discussion

Be prepared to discuss the following topics if you are asked to do so:

1. Typical unsafe conditions and unsafe acts that cause accidents
2. The proper maintenance of tools and equipment for safety
3. Safety requirements for scaffolds
4. Cooperation with other workers to ensure on-the-job safety

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 3--SAFE WORKING PRACTICES - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Both the __1__ and the __2__ contribute a part in the prevention of accidents on the job.	1. ________ 2. ________
2. An accident is an __3__ and __4__ event that interrupts normal work activity.	3. ________ 4. ________
3. Accidents are usually caused by a combination of __5__ __6__ and __7__ __8__.	5. ________ 6. ________ 7. ________ 8. ________
4. The apprentice should actively support __9__ __10__ programs.	9. ________ 10. ________
5. Hazardous operations require the use of __11__ __12__.	11. ________ 12. ________
6. The head of a chisel should never be allowed to become __13__.	13. ________
7. Powder-actuated tools should be treated with the same respect accorded to __14__.	14. ________
8. Electrical tools must be properly __15__.	15. ________
9. Heavy glass cases should be handled with __16__.	16. ________
10. Always carry glass in the __17__ position.	17. ________
11. Broken glass should be removed from a window with __18__ __19__ or __20__.	18. ________ 19. ________ 20. ________
12. Dangerous locations in construction areas should be __21__ or __22__.	21. ________ 22. ________

13. In general, construction elevators are not intended for carrying __23__. 23. ________

14. Safety laws that apply on the job are enforced by the State Division of __24__ __25__. 24. ________ 25. ________

15. The basic responsibility for safety on the job lies with the __26__. 26. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Analysis of the causes of accidents is a part of accident prevention.	1.	T	F
2. Scaffolds may be constructed of wood or metal.	2.	T	F
3. Extension ladders may be used fully extended.	3.	T	F
4. A California contractor who develops his own safety code need not follow the State's <u>Construction Safety Orders</u>.	4.	T	F
5. A scaffold 12 feet off the ground should have a backrail.	5.	T	F
6. Relatively mild electrical shocks can cause serious accidents.	6.	T	F
7. Extension cords for portable electric tools should have three conductors.	7.	T	F
8. Web straps should be used for carrying large pieces of glass.	8.	T	F
9. Glass may be carried up a metal extension ladder.	9.	T	F
10. The mechanic should work from the bottom up when removing broken glass from a window.	10.	T	F

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 4--LAWS, BENEFITS, AND SERVICES OF SPECIAL INTEREST TO WORKMEN

This topic, "Laws, Benefits, and Services of Special Interest to Workmen," is planned to help you find answers to the following questions:

- How does the social security law contribute to the security of the worker?
- What benefits are available to California workers under the workmen's compensation law?
- What services and benefits does the State Department of Employment offer to California workers?

The apprentice glazier should have a knowledge of the federal and state laws that contribute to his security as a worker and affect the conditions of his employment, and he should understand the benefits and services that are available to him if he should be unemployed, suffer injury on the job, or become disabled.

The Social Security Law

The federal social security law provides for monthly retirement payments to insured workers and, under certain conditions, to their wives and dependent children; monthly survivors' payments to widows or other dependents of deceased insured workers; and payments to totally disabled insured workers under 65 years of age and to certain of their dependents. Nine out of ten workers in the United States participate in the social security program.

Retirement benefits. To be eligible for retirement benefits under the social security law, the worker must be fully insured and must be at least 62 years of age. Monthly payments can also be made to his wife if she is at least 62 years old or if she is caring for his dependent child. A worker is fully insured under the social security law when he has completed the required number of calendar quarters of covered employment. He must have completed at least six quarters of such employment and may be required to have completed as many as 40 quarters, depending upon the year in which he will reach the age of 65.

Survivor's benefits. If the worker is fully insured at the time of his death, monthly payments can be made to his widow, if she is at least 60 years old or is caring for his eligible child, and to his dependent children and dependent parents. Benefits may be available to certain survivors even if the worker was not fully insured at the time of his death. The social security law also provides for the payment of a small lump-sum death benefit to the deceased worker's widow.

Disability benefits. If before age 65 a fully insured worker becomes disabled and is therefore unable to work over a long period of time, he and certain members of his family may be eligible for disability payments under the social security law. To qualify, the worker must be unable to do substantial gainful work, and he must have a disability that has lasted (or is expected to last) for at least 12 months and that in other respects meets the requirements of the law.

The social security card. The worker should obtain a social security card as soon as he starts on his first job covered by the law. The number shown on the card will be used by the Social Security Administration to keep a record of his earnings in covered jobs. If the card is lost, application for a duplicate card can be made at any social security office. Reference to the social security number must be made in applying for benefits under the law.

Keeping informed. The worker can obtain specific and current information concerning eligibility for retirement and other benefits under the social security law, determine his current insurance status, or get answers to any other questions relating to the social security program at local offices of the Social Security Administration, U. S. Department of Health, Education, and Welfare.

Other Federal Laws Affecting the Worker

Among the federal legislative acts that are of particular concern to the worker are the Fair Labor Standards Act, the Walsh-Healy Act, the Taft-Hartley Act, and the Landrum-Griffin Act.

The Fair Labor Standards Act sets minimum wages and maximum working hours for all workers engaged in interstate commerce or in the production of goods for interstate commerce. Although this law does not directly affect many of the skilled trades, it does tend to raise the level of pay and reduce working hours for workers in general.

The Walsh-Healy Act, as amended, establishes standards for pay and working conditions for persons employed under federal government contracts or subcontracts. This legislation, like the Fair Labor Standards Act, has the effect of promoting better working conditions and raising pay levels for workers other than those directly affected by the legislation.

The Taft-Hartley Act (the Labor-Management Relations Act) is an amendment of the National Labor Relations Act of 1935. The Labor Relations Act as amended guarantees the right of workers to organize and bargain collectively with their employers, permits the existence of a union shop, prohibits a closed shop, and requires a 60-day cooling-off period before a strike or lockout can be called. The Taft-Hartley Act contains a number of other provisions, many of which are considered controversial but all of which are of concern to the worker in his relations with his union and his employer.

The Landrum-Griffin Act (the Labor-Management Reporting and Disclosures Act) outlines a "bill of rights" for union members; requires labor organizations

and employers to report regularly on certain of their activities; sets standards regarding union elections, the handling of union funds, and the qualifications of union officers; and prohibits secondary boycotts, certain kinds of strikes and picketing, and certain kinds of labor contracts.

California Workmen's Compensation Law

Most California employers are required by the provisions of the California workmen's compensation law to guarantee certain benefits to employees injured on the job. Every employer who is so obligated must post a notice either giving the name of his workmen's compensation insurance carrier or stating that he is self-insured. Benefits available to workers whose employment is covered by the law may be one or more of the following: medical care or reimbursement for medical expenses; disability payments and pensions; subsequent injury payments; and death benefits.

Medical care. Under the workmen's compensation law, all medical treatment a worker may need as a result of an industrial injury (an injury occurring in the course of his employment and arising out of his employment) must be provided for by the employer or his insurance company. If the employer fails to provide for such treatment, the worker may arrange for the treatment himself and, through the Workmen's Compensation Appeals Board, seek to charge its cost to the employer. Benefits for medical treatment include pay for time lost in the course of required medical examinations; reasonable expenses for transportation, meals, and lodging, when necessary; and payments for examinations, x rays, and laboratory tests needed to prove the injured worker's claim for workmen's compensation.

Disability benefits. If a worker suffers a temporary disabling injury on the job, he will receive payment under the workmen's compensation law for all or part of his resulting loss of earning power, depending upon the duration of the disability. A worker permanently disabled as a result of such an injury may receive compensation in an amount determined by the rating assigned to the disability by the Division of Industrial Accidents. A permanently disabled worker can receive a lifetime pension if the severity of his disability entitles him to this benefit.

Subsequent injury payments. A worker who is partially but permanently disabled at the time he sustains a further-disabling on-the-job injury may be entitled to special benefits under the workmen's compensation law. Eligibility for these benefits is determined in part by the relationship of the existing disability and the subsequent injury.

Death benefits. The workmen's compensation law provides for the payment of certain benefits to the survivors of a worker whose on-the-job injury results in his death. These benefits include burial expenses, up to a specified maximum amount, for the deceased worker and a substantial death benefit payment to the worker's widow, dependent children, or other specified dependents.

Reporting injuries. The worker should notify his employer, his superintendent, or his foreman as soon as possible in the event of his on-the-job injury or

claim of injury. If he should fail to give such notice within 30 days after being injured, his claim may be denied. The employer is required by law to report to his insurance company every claim of injury within five days after he learns of it.

Application for adjustment of benefits. If the worker thinks that his workmen's compensation benefits have not been accurately determined, he should apply to the Division of Industrial Accidents, California State Department of Industrial Relations, for their review and possible adjustment. Application for adjustment of benefits should be filed within one year from the date of the injury or the date of the last medical treatment for the injury.

Keeping informed. Additional information concerning the workmen's compensation law can be obtained at any branch office of the Workmen's Compensation Appeals Board, Division of Industrial Accidents, California State Department of Industrial Relations.

Services of the California State Department of Employment

The California State Department of Employment performs three major functions in providing assistance to workers in the state: (1) operates a statewide system of public employment offices to assist unemployed persons to find work as quickly as possible; (2) pays unemployment insurance benefits to eligible workers; and (3) pays disability insurance and hospital benefits to eligible workers who are unemployed because of sickness or injury that did not result from the job.

The public employment offices of the Department of Employment help workers find suitable jobs and help employers fill job vacancies. These offices also accept claims for unemployment insurance and for disability insurance.

Public employment service. The placement of tradesmen is in many instances accomplished almost exclusively through the offices of their unions; the tradesman who is seeking employment will, therefore, usually apply first to his local union office. If no work is available there, he should go to the Department of Employment to register for work and file for unemployment insurance benefits. Job placement and vocational counseling services are available to all persons at all times at public employment offices; a worker does not have to be a claimant for unemployment insurance to use these services.

Unemployment insurance. Certain employers in California, including most of those hiring glaziers, are covered by the California Unemployment Insurance Code. As soon as a covered worker becomes unemployed, he should file a claim for unemployment insurance benefits. To be eligible for such benefits, he must have earned a specified amount of wages in employment covered by the law; the amount of the benefits will depend upon the wages earned. A worker currently residing in California may file his claim at any public employment office, even though his work in covered employment may have been performed outside the state. Other states in turn serve as agents for claims against California earnings by workers who have left California.

To receive unemployment benefits, the worker must be unemployed but physically able to work; he must be available for work; and he must be willing to make a diligent effort to find a job on his own. In addition, he must not have quit his job voluntarily without good cause; he must not have left his work because of a trade dispute; he must not have quit for family reasons, except in specified circumstances; and he must not refuse to apply for or accept suitable work. If the worker is still unemployed seven days after he has filed his claim, he can receive benefits for a specified period of subsequent unemployment. During the seven-day waiting period, his eligibility will be examined and his benefits computed. He must meet all the eligibility requirements for unemployment insurance during the waiting period, despite the fact that he will not be entitled to benefits for that week.

If the worker does not meet the requirements for eligibility, he is disqualified from receiving benefits for a period of at least five weeks, but no more than eight weeks. Disqualification does not necessarily mean that he loses his eligibility permanently; it usually means only that he may not begin to draw benefits until after this waiting period. Even though a worker has been disqualified, he must meet all conditions of eligibility, including reporting weekly, to avoid loss of benefits after the period of disqualification has ended. Denials of benefits may be appealed through local offices of the Department of Employment. An impartial referee will hear and decide the appeal. A referee's decision may be appealed to the California Unemployment Insurance Appeals Board.

A worker who has become "partially" or "part-totally" unemployed, in the definition of the Department of Employment, may also be entitled to receive insurance payments if the amount he earns does not exceed his weekly benefit amount. A partially unemployed worker is one who has had his work (and thus his earnings) reduced below the regular number of working hours or has been laid off but expects to return to work with his regular employer within two weeks. If he is partially unemployed, he will need to present a "Notice of Reduced Earnings" when he files his insurance claim. A part-totally unemployed worker is one who earns less than his weekly benefit amount at casual jobs, who is actively seeking full-time employment, and who is available for and physically able to accept suitable employment if it is offered to him.

Disability insurance. Certain employees are protected by the disability insurance provisions of the California Unemployment Insurance Code. Such employees are insured either under a state plan or under a state-approved voluntary plan with a private insurance company. (If your place of employment is covered by such a private plan, consult your policy or your employer to determine your benefits and eligibility requirements.) Just as employers pay for unemployment insurance through a tax on wages, employees pay for disability insurance through contributions based on their earnings. If the worker is unemployed because of nonoccupational illness or injury and has received sufficient wages in employment covered under the California Unemployment Insurance Code, he may be eligible for disability insurance benefits (not to be confused with workmen's compensation benefits, which are paid to eligible workers who suffer on-the-job injuries). If he is hospitalized, the worker may be eligible for hospital benefits in addition to disability benefits under this plan. Additional

information concerning disability insurance and other benefits and services offered the worker by the State Department of Employment may be obtained at any public employment office.

Topics for Discussion

Be prepared to discuss the following topics if you are asked to do so:

1. The value of the social security program in the development of your personal plan for retirement
2. The effect of federal labor legislation on the pay levels and working conditions of the skilled worker
3. The benefits available to a glazier who suffers a disabling injury on the job and the benefits available to a glazier who becomes disabled as the result of a hunting accident
4. The steps you would take to find another job in the glazing industry in the event of a layoff in your shop and the steps you would take to provide income for yourself and your family while you were seeking employment

UNIT A--THE APPRENTICE GLAZIER AND HIS TRADE

TOPIC 4--LAWS, BENEFITS, AND SERVICES OF SPECIAL INTEREST TO WORKMEN - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. To be eligible for retirement benefits under the social security law, the worker must be fully __1__. — 1. ________

2. Social security benefits for the survivors of an insured worker can include __2__ payments to his dependent children. — 2. ________

3. The Social Security Administration keeps a record of the worker's __3__ in covered jobs; this record is identified by means of the worker's __4__ __5__ __6__. — 3. ________ 4. ________ 5. ________ 6. ________

4. The __7__ - __8__ Act establishes standards for pay and working conditions for persons employed under government contracts. — 7. ________ 8. ________

5. Most California employers are required to insure their employees against loss of earning power due to injuries suffered __9__ __10__ __11__. — 9. ________ 10. ________ 11. ________

6. Any on-the-job injury or claim of injury should be reported to the employer as soon as possible and in no event later than __12__ days after the date of the injury. — 12. ________

7. Application for adjustment of workmen's compensation benefits should be made within __13__ __14__ from the date of the injury or the date of the last medical treatment for the injury. — 13. ________ 14. ________

8. The California State Department of Employment operates a __15__ system of public employment offices. — 15. ________

9. As soon as a glazier becomes unemployed, he should file a claim for __16__ __17__ benefits.

16. ________
17. ________

10. The California Unemployment Insurance Code provides for the payment of __18__ __19__ benefits to covered workers whose unemployment is due to nonoccupational illness or injury.

18. ________
19. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The social security law applies to all workers in the United States.	1.	T	F
2. The provisions of the social security law require that the worker be fully insured to be eligible for retirement benefits.	2.	T	F
3. After a worker has completed a minimum of one year of covered employment, he is fully insured under the social security law.	3.	T	F
4. To be eligible for the disability benefits of the social security law, a worker must be fully insured and must have a disability that will prevent him from working for a long time.	4.	T	F
5. The Fair Labor Standards Act directly affects wage levels and maximum working hours for workers engaged in interstate commerce.	5.	T	F
6. The Walsh-Healy Act establishes pay standards for persons employed under state government contracts.	6.	T	F
7. The California workmen's compensation law provides for the compensation of any worker who is injured on the job.	7.	T	F
8. Application for adjustment of workmen's compensation benefits may be made to the Division of Industrial Accidents.	8.	T	F
9. The California State Department of Employment pays disability benefits to workers who are injured on the job.	9.	T	F
10. Local unions usually provide job placement assistance for their members.	10.	T	F

UNIT B Basic Mathematics

TOPIC 1--WHOLE NUMBERS

This topic, "Whole Numbers," is planned to help you find answers to the following questions:

- What is a whole number?
- How are whole numbers added, subtracted, multiplied, and divided?

If the apprentice glazier is to become competent in his trade, he must acquire a thorough knowledge of simple mathematical processes. One of the most important factors in glazing work is size information. The glazier must accurately determine required sizes for glass, he must plan cuts to minimize glass waste, and he must verify the sizes of openings and related structures to ensure accurately fitted glazing work. These and many other operations in glazing require the use of basic mathematics.

The ability to add, subtract, multiply, and divide numbers is essential for the performance of even the simplest mathematical calculations. These basic mathematical operations will be reviewed in this topic using whole numbers--numbers that do not contain fractions or that are not in themselves fractions.

Study Assignment

Glenn M. Hobbs, James McKinney, and J. Ralph Dalzell. Practical Mathematics. Chicago: American Technical Society, 1940, pp. 1-23 of Section 1.

UNIT B--BASIC MATHEMATICS

TOPIC 1--WHOLE NUMBERS - STUDY GUIDE AND TEST

Study Guide

After you have read the material in the workbook and studied the assigned material, test your understanding of the topic as follows:

1. Solve the following practice problems in Practical Mathematics, Section 1: 1-3, p. 7; 1-3, p. 11; 1-7, pp. 16 and 17; and 1-7, p. 23.

2. Complete the trial examination in Practical Mathematics, Section 1, p. 24.

UNIT B--BASIC MATHEMATICS

TOPIC 2--COMMON FRACTIONS

This topic, "Common Fractions," is intended to help you find answers to the following questions:

- What is a common fraction, and how does it differ from a whole number?
- What is meant by the "reduction" of a common fraction?
- How are common fractions added, subtracted, multiplied, and divided?

Fractional dimensions and dimensions that include fractions as well as whole numbers--as in a 7/8-in. wide sash, or a 27-1/2 in. x 30-3/8 in. light of glass, for example--are frequently encountered in glazing work. The study assignment discusses the basic mathematics of common fractions, which are fractions with both the numerator and the denominator expressed, as in the examples given above.

Study Assignment

Practical Mathematics: pp. 1-46 of Section 3; pp. 1-26 of Section 4.

UNIT B--BASIC MATHEMATICS

TOPIC 2--COMMON FRACTIONS - STUDY GUIDE AND TEST

Study Guide

After you have read the material in the workbook and studied the assigned material, test your understanding of the topic as follows:

1. Solve the following practice problems in Practical Mathematics, Section 3: 1-5, p. 11; 1-5, p. 13; 1-5 and 11-15, p. 21; 1-5, pp. 26 and 27; 1-5, p. 29; 1-12, p. 34; 1-5, p. 38; 1-10, p. 41; and 1-10, p. 46.

2. Solve the following practice problems in Practical Mathematics, Section 4: 1-4, p. 3; 1-10, p. 8; 1-6, p. 10; 1-5, p. 11; 1-10, p. 15; 1-10, p. 18; 1-5, p. 20; 1-10, p. 21; 1-6, p. 23; 1-6, p. 24; and 1-10, p. 26.

UNIT B--BASIC MATHEMATICS

TOPIC 3--DECIMAL FRACTIONS

This topic, "Decimal Fractions," is intended to help you find answers to the following questions:

- What is a decimal fraction, and how does it differ from a common fraction?
- How are decimal fractions changed to common fractions, and how are common fractions changed to decimal fractions?
- How are decimal fractions added, subtracted, multiplied, and divided?

A decimal fraction (or "decimal") is a fraction with only the numerator expressed, the value of the denominator being indicated by the position of the decimal point to the left of the numeral. The unexpressed denominator of a decimal fraction will always be either ten or a multiple of ten (100, 1000, and so forth). For example, the decimal fraction 0.5 is equal to the common fraction 5/10; 0.05 is equal to 5/100; 0.005 is equal to 5/1000; and so on.

Decimal fractions are employed in many figuring operations in the glazing trade. Their use is of course required in making estimates of labor and material costs, in ordering and billing, and in keeping financial records of all kinds, because the money system of the United States is based on the decimal system; and many sizes and metal tolerances in glazing, as in craft work in general, are expressed decimally.

Study Assignment

<u>Practical Mathematics</u>: pp. 1-21 of Section 5.

UNIT B--BASIC MATHEMATICS

TOPIC 3--DECIMAL FRACTIONS - STUDY GUIDE AND TEST

Study Guide

After you have read the material in the workbook and studied the assigned material, test your understanding of the topic by solving the following practice problems in Practical Mathematics, Section 5: 1-4, p. 7; 1-5, pp. 9 and 10; 1-9, pp. 12 and 13; 1-5, p. 14; and 1-8, p. 20.

UNIT B--BASIC MATHEMATICS

TOPIC 4--PERCENTAGE

This topic, "Percentage," is planned to help you find answers to the following questions:

- What is "percentage"?
- In what ways are percentage problems similar to problems involving common and decimal fractions?
- What is the "decimal equivalent" of a common fraction, and what is the "fractional equivalent" of a decimal fraction?

"Percentage" is a term employed in arithmetic to denote the method of expressing a fractional part of a whole as hundredths of the whole. As an example of the method, assume that a 10-ft.-square piece of glass is cut into 100 equal squares; each 1 ft. square then represents one hundredth or one percent (1%) of the original whole piece. Ten such squares equal 1 percent of the whole; 50 squares equal 50 percent of the whole; and all 100 pieces taken together equal 100 percent of the whole. Percentage thus provides a means of indicating the relationship of the parts to the whole: a quarter is 25 percent of a dollar, and a pint is 12-1/2 percent of a gallon.

The processes employed in the solution of percentage problems are similar to those employed in the solution of problems involving common fractions and decimal fractions. It has been shown that common fractions can be changed to decimal fractions, and vice-versa: 1/100 and 0.01 are equal in value, as are 0.25 and 1/4. The common fraction 1/100 is the "fractional equivalent" of 0.01, and the decimal fraction 0.25 is the "decimal equivalent" of 1/4. In this topic it will be shown that fractions can be expressed as percent, and that 1/100, 0.01, and 1 percent are three ways of writing the same quantity.

Proportional relationships in glass work are often described in terms of percent. For example, a type of plate glass may consist of 25 percent cullet and 75 percent raw materials, and an aluminum sash may weigh 50 percent less than an equivalent wood sash. Percentage problems are also encountered in the business aspects of glazing, as in the determination of costs, profits, discounts, and interest rates; the glazier must be prepared to solve such problems.

Study Assignment

Practical Mathematics: pp. 1-40 of Section 6.

UNIT B--BASIC MATHEMATICS

TOPIC 4--PERCENTAGE - STUDY GUIDE AND TEST

Study Guide

After you have read the material in the workbook and studied the assigned material, test your understanding of the topic by solving the following practice problems in Practical Mathematics, Section 6: 1-16, pp. 11 and 12; 1-8, p. 14; 1-10, p. 18; 1-6, p. 20; 1-8, p. 22; and 1, 3, 5, 8, 11, and 22-30, pp. 32 and 33.

UNIT B--BASIC MATHEMATICS

TOPIC 5--COMPOUND NUMBERS

This topic, "Compound Numbers," is planned to help you find answers to the following questions:

- What is a compound number?
- How are compound numbers added, subtracted, multiplied, and divided?
- Where are compound numbers employed in glazing?

Measurements in glazing often involve two or more related units of measure, such as feet and inches or pounds and ounces. The expressions of such measurements--6 ft. 5 in., for example--are called compound numbers. Dimensions involving compound numbers often must be added, subtracted, multiplied, or divided. The first step in performing any of these operations is the reduction, or changing, of the related but dissimilar units to one kind of unit, because only like units can be combined in an arithmetical operation.

Working with Compound Numbers

After the unlike but related units in a compound number have been reduced to like units, the number can be added, subtracted, multiplied, or divided in the conventional way. The principles of working with compound numbers are outlined in the illustrative problems presented in this topic. Each problem is accompanied by its step-by-step solution. The only units of measure employed in the problems are feet and inches, but the principles demonstrated apply equally to compound numbers involving such other unlike related units as gallons, quarts, and pints, hours and minutes, or pounds and ounces.

<u>Reduction from higher to lower denomination units</u>

Problem: Reduce 13 feet to inches.

Step 1. $1' = 12''$
Step 2. $13 \times 12'' = 156''$

<u>Reduction from lower to higher denomination units</u>

Problem: Reduce 216 inches to feet.

Step 1. $12'' = 1'$
Step 2. $216'' \div 12 = 18'$

Addition of compound numbers

Problem: Add 2'7" to 8'10"

$$\begin{array}{r} 2' \ \ 7'' \\ +8' \ 10'' \\ \hline 17'' \end{array}$$

Step 1. Add the inch column.

7" + 10" = 17"

Step 2. Reduce the inches to feet and inches.

17" = 1'5"

Write the 5" in the sum and carry the 1' from the inch column to the foot column.

$$\begin{array}{r} (1') \ \ \ \ \ \ \\ 2' \ \ 7'' \\ +8' \ 10'' \\ \hline 5'' \end{array}$$

Step 3. Add the foot column.

1' + 2' + 8' = 11'

$$\begin{array}{r} (1') \ \ \ \ \ \ \\ 2' \ \ 7'' \\ +8' \ 10'' \\ \hline 11' \ \ 5'' \end{array}$$

Subtraction of compound numbers

Problem: Subtract 3'4" from 9'2".

Step 1. Since 4" cannot be subtracted from 2", borrow 12" from the 9' and add to the 2", thus changing the compound number 9'2" to 8'14".

Step 2. Subtract both columns.

14" - 4" = 10"

8' - 3' = 5'

$$\begin{array}{r} 8' \ 14'' \\ -3' \ \ 4'' \\ \hline 5' \ 10'' \end{array}$$

Multiplication of compound numbers by whole numbers

Problem: Multiply 3'7" by 8.

Step 1. Multiply the inches by 8.

7" × 8 = 56"

Step 2. Reduce the product to feet.

56" = 4'8"

$$\begin{array}{r} 3' \ \ 7'' \\ \times \ \ \ \ \ \ 8 \\ \hline 56'' \end{array} = 4'8''$$

Step 3. Multiply the number of feet in the multiplicand by 8.

3' × 8 = 24'

Step 4. Add the results of Steps 2 and 3.

4'8" + 24' = 28'8"

```
  3'  7"
×     8
24'+4'8" = 28'8"
```

Division of compound numbers by whole numbers

Problem: Divide 31'3" by 15.

Step 1. Reduce the feet to inches.

31' = 372"

Step 2. Add the total number of inches.

3" + 372" = 375"

Step 3. Divide the sum by 15.

375" ÷ 15 = 25"

Step 4. Reduce the quotient to feet.

25" = 2'1"

Problems involving compound mixed numbers. If the lowest-denomination units in a problem involving compound numbers are expressed in fractions, one must first reduce the fractions to the lowest common denominator before proceeding with the calculation. The following problem illustrates this point.

Problem: Add 12'8-1/2", 17'4-3/8", 5'5-1/4", 2'10-5/8".

Step 1. Reduce the fractions to terms of the lowest common denominator.

```
LCD = 8
1/2  = 4/8
1/4  = 2/8
```

Step 2. Add the fraction column and reduce the sum to inches.

4/8" + 3/8" + 2/8" + 5/8" = 14/8"

14/8" = 1-6/8" = 1-3/4"

Write the fraction 3/4" in the sum, and carry the 1" to the inch column.

```
      (1")
12'  8-4/8"
17'  4-3/8"
 5'  5-2/8"
 2' 10-5/8"
      3/4"
```

Step 3. Add the inch column and reduce the sum to feet.

1" + 8" + 4" + 5" + 10" = 28"

28" = 2'4"

```
(2')
12'  8-4/8"
17'  4-3/8"
 5'  5-2/8"
 2' 10-5/8"
38'  4-3/4"
```

Step 4. Add the foot column.

$2' + 12' + 17' + 5' + 2' = 38'$

Quick method of multiplying compound numbers. It is frequently necessary to find the area of a surface where both the length and width are expressed in compound numbers. Although it is of course possible to multiply the compound numbers, it is often easier and sufficiently accurate to reduce the compound numbers to mixed numbers. For example, to multiply 14'6" by 8'4" to find the area of a piece of glass, simply change the 6" to 1/2' and the 4" to 1/3' and then multiply 14-1/2' by 8-1/3'.

Division of compound numbers by compound numbers. Occasionally, a glazier will need to divide one compound number by another compound number, as for example when he must find out how many short pieces of sash material can be taken from one long piece. The steps in solving a typical problem of this type are as follows:

Problem: Divide 12'8" by 3'2".

Step 1. Reduce the feet to inches in each compound number.

12' = 144"

3' = 36"

Step 2. Add the inches in each reduced number.

144" + 8" = 152"

36" + 2" = 38"

Step 3. Divide.

152" ÷ 38" = 4

UNIT B--BASIC MATHEMATICS

TOPIC 5--COMPOUND NUMBERS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, test your understanding of the topic by solving the following problems. Record the answer to each problem in the space at the right that has the same number as that of the problem.

1. Change 372" to feet.	1. ____________
2. Change 16'8" to inches.	2. ____________
3. Add 4'8", 17'3", 11'5", 44'2", and 32'10".	3. ____________
4. Subtract 23'8" from 57'2".	4. ____________
5. Subtract 28'11" from 32'10".	5. ____________
6. Multiply 3'8" by 9.	6. ____________
7. Multiply 22'4" by 37'11".	7. ____________
8. Divide 11'6" by 3.	8. ____________
9. Divide 19'2" by 3'10".	9. ____________
10. Add 7 hr. 18 min. and 3 hr. 47 min.	10. ____________

UNIT B--BASIC MATHEMATICS

TOPIC 6--AREAS OF CIRCLES AND TRIANGLES

This topic, "Areas of Circles and Triangles," is planned to help you find answers to the following questions:

- What is meant by the term "mensuration"?
- How is the area of a circle found?
- How is the area of a triangle found?

A number of operations in glazing involve the determination of the areas and angles of pieces of glass, metal, and other materials. A knowledge of mensuration, the branch of applied geometry concerned with finding the length of lines, the areas of surfaces, and the volumes of solids, is essential for solving such problems.

Study Assignment

Practical Mathematics: Section 12, pp. 1-42.

UNIT B--BASIC MATHEMATICS

TOPIC 6--AREAS OF CIRCLES AND TRIANGLES - STUDY GUIDE AND TEST

Study Guide

After you have read the material in the workbook and studied assigned material, test your understanding of the topic as follows:

1. Solve the following practice problems in Practical Mathematics, Section 12: 1-8, p. 6; 1-5, p. 11; 1-3, p. 16; 1-6, pp. 21 and 22; 1-4, p. 27; 1 and 2, p. 30; and 1-6, pp. 40 and 41.

2. Complete the trial examination in Practical Mathematics, Section 12, p. 43.

UNIT C Applied Mathematics

TOPIC 1--STORE FRONTS

This topic, "Store Fronts," is planned to help you find answers to the following questions:

- What glass-to-metal clearances must be calculated in store-front glazing?
- In cutting a light for store front glazing, how much allowance is typically made for penetration of the glass into the glazing pockets of the metal framing tubes?
- How do required glass-to-metal clearances affect the determination of sizes for glass and metal?

The construction of store fronts is a large and important part of the glazier's work. Quite often, store fronts are constructed with aluminum extrusions and glass. The mathematics and procedures for calculating the various sizes and clearances involved in store-front work are the subject matter of this topic. The general knowledge acquired here will apply to all store-front construction. No effort will be made in this topic to cover the entire field of store-front construction; installation methods will be covered in Unit H of this course.

An elevation view illustrating a typical store front construction is given in Fig. C-1 (a). Quarter-size details of a vertical cross section taken through E, J, and K of the elevation are given in Fig. C-1 (b); those of a horizontal cross section taken through S and N are given in Fig. C-1 (c). A study of the elevation view and the related cross section details will reveal the various clearances allowed for the different materials involved. Referring to the top section (E) of Fig. C-1 (b), the glazier will note that an allowance has been made for clearance between the tube section and the R. O. (rough opening). This example illustrates the standard procedure, which is to allow for a 1/4-in. bead of sealant to be applied at all joints between metal and the material of the rough opening. This does not apply at a bulkhead; this metal is set tight to the R. O., as in detail K, Fig. C-1 (b).

Details E, J, and K in Fig. C-1 (b) are good examples of the spacing relationships between metal and glass in store fronts. The glass penetrates the glazing pocket approximately 1/2 in. Two exceptions to this are illustrated in Fig. C-2. In the tube section shown in Fig. C-2 (a), the top pocket is deeper than the bottom pocket, and the glass penetrates the shallow pocket only 3/8 in. An example of a tube section with applied stops is Fig. C-2 (b). In this instance, the glass penetrates 3/8 in. into the pocket formed by the stops.

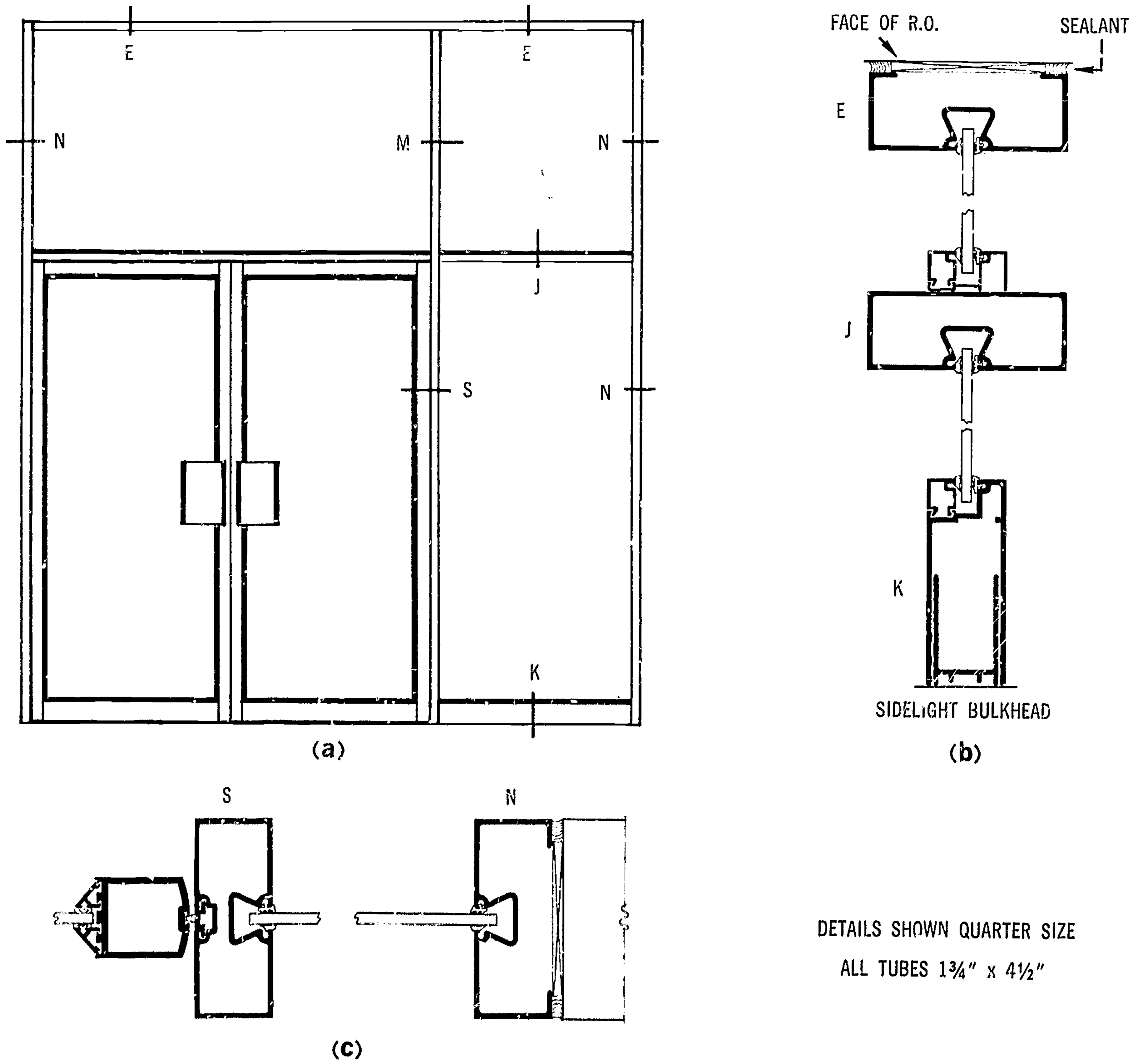


Fig. C-1. Typical store-front elevation and sections

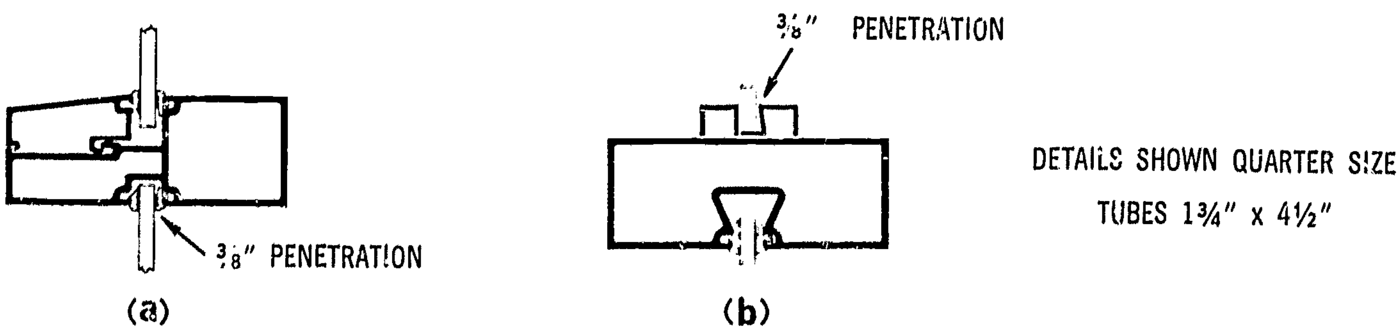


Fig. C-2. Glass penetration in shallow pockets

The 1/2 in. glass penetration as it applies in other typical glazing sections is illustrated in Fig. C-3. To establish the correct size for either glass or metal, the required penetration of the glass must be taken into account. The light of glass adjacent to the door in the store-front elevation, Fig. C-1(a), would therefore be 1 in. wider than the daylight dimension of the opening, as details S and N in Fig. C-1 (c) indicate.

Many different types of glazing members are used in store-front construction, and some types will not conform exactly to the examples that have been covered in this topic. In every case, however, an awareness of the need for adequate clearance between glass and glazing member is of paramount importance in doing a professional job.

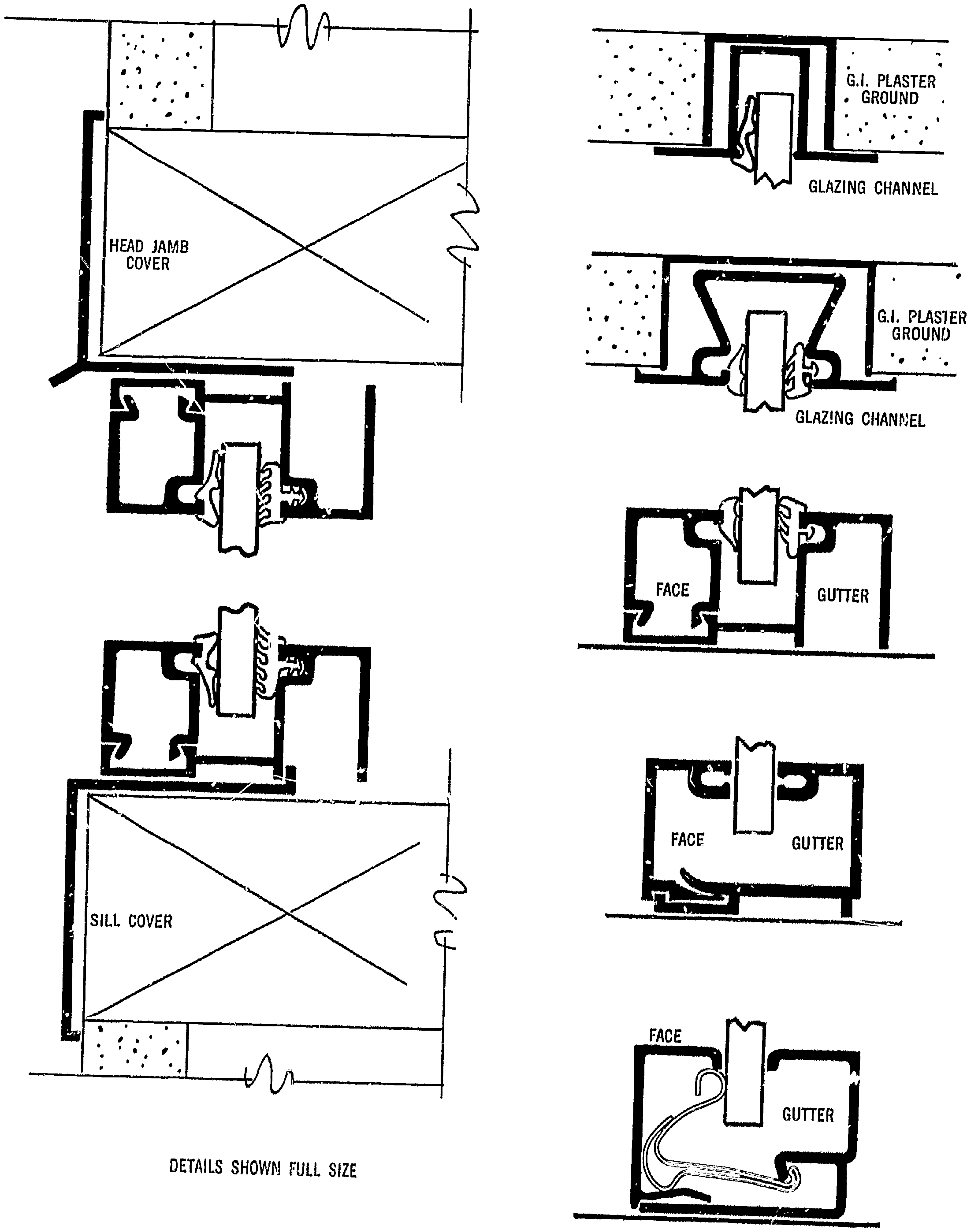


Fig. C-3. Glass penetration in typical glazing sections

UNIT C--APPLIED MATHEMATICS

TOPIC 1--STORE FRONTS - STUDY GUIDE AND TEST

After you have studied the material in the workbook, solve the following problems:

1. Referring to Fig. C-1, calculate the sizes of glass required for the transom area, allowing for required clearances. Assume the width of the rough opening to be 9 ft. 1 in. and the distance from the left face of the rough opening to the center of the vertical tube "M" to be 74-3/4 in. (All tubes in Fig. C-1 are 1-3/4 in. by 4-1/2 in. flush glazing.) Assume the height dimension of the transom glass to be 40 in.

2. Change the height and width dimensions given in the above problem, and again calculate the glass sizes. Construct and solve a number of problems in this way for practice.

UNIT C--APPLIED MATHEMATICS

TOPIC 2--METAL AND GLASS MEASUREMENTS

This topic, "Metal and Glass Measurements," is planned to help you find answers to the following questions:

- What considerations are important in the development of material sizes in glazing?
- What clearances and tolerances apply between glass and other materials in various types of glazing jobs?
- Why must variable coverage requirements be taken into account in the calculation of glass sizes?

It is impossible to do a professional glazing job if accurate size information for the various materials involved is not available. Too often, clearances and tolerances between glass and metal or other material become a matter of guesswork. In this topic, an attempt will be made to indicate some patterns of procedure and some general rules that may be applied when the mechanic is called upon to develop material sizes in glazing work.

Glass must have a clearance around its perimeter between the glass edge and the inner face of the glazing pocket. The clearances and tolerances given in the reading assignment are typical. The clearance required may vary depending upon the type of material employed to hold the glass in place. Also, some types of glass require more clearance than others; the heat absorbing glasses are an example of this.

Two typical store front elevations are shown in Fig. C-4. The letter-designated sections indicated on the elevation drawings are keyed to quarter-size details having the same letter designations in Fig. C-5. Other typical metal details are illustrated in Figs. C-6 through C-8. A careful study of the drawings will provide familiarization with typical metal and glass clearances.

The detail drawings provide examples of metal sash, tubes, bulkheads, and division and corner bars. Some slight differences in glass edge clearances are evident from one to the other of these metal units. This is most pronounced in the corner and division bars shown in Fig. C-7. The standard 1/2 in. glass coverage does not apply in every instance here. The 9/16 in. division bar, for instance, shows a variation in coverage. Because of the offset in the attaching reglet of the face member, one light of glass penetrates the bar 3/8 in., the other 5/8 in. Also, glass penetration in the corner and reverse bars is slightly greater than in the division bars. This is due to the angle at which the glass is installed; the more acute the angle, the greater the glass penetration. It may be said, then, that variable coverage requirements must be taken into account when glass sizes are calculated.

Study Assignment

Architectural Data Handbook. Pittsburgh: Pittsburgh Plate Glass Company, 1965, pp. 48 and 49.

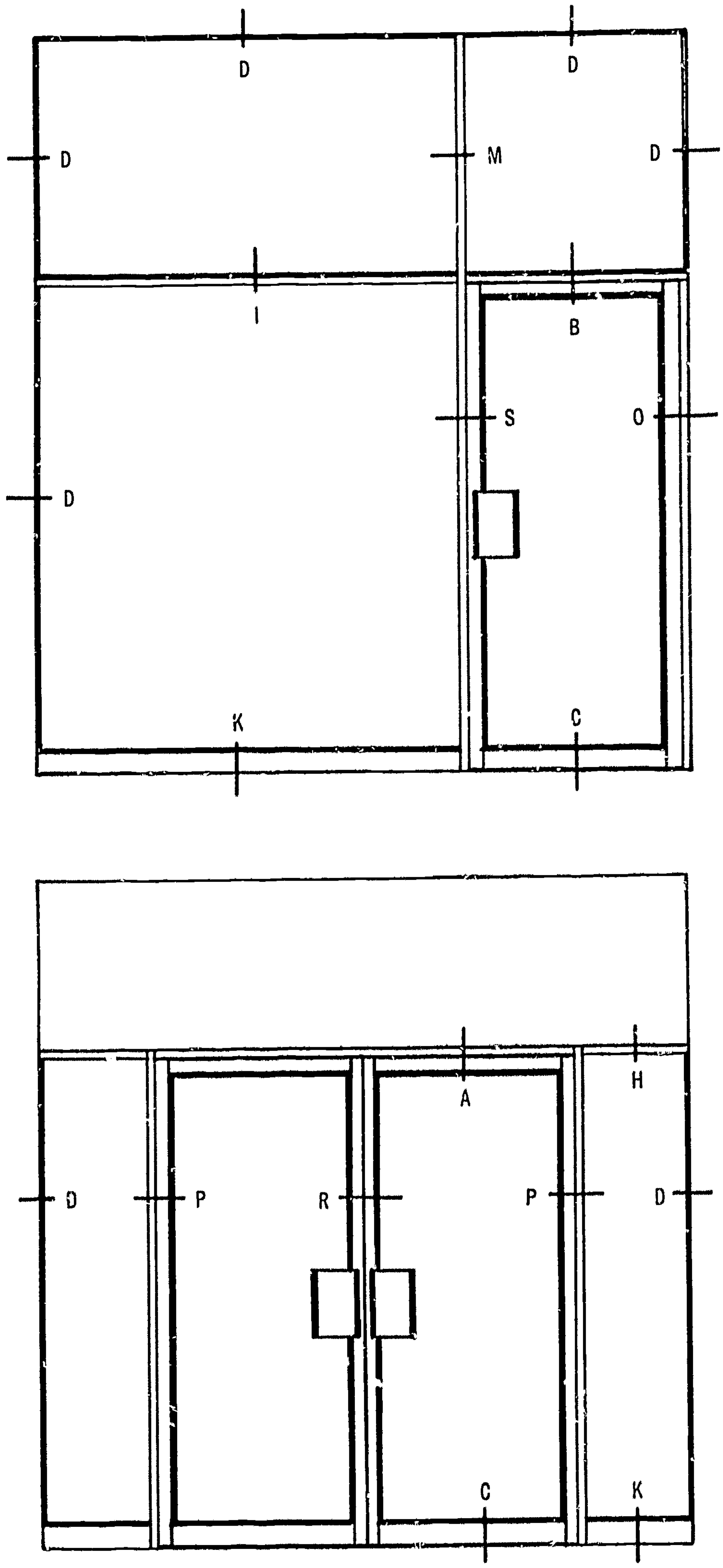


Fig. C-4. Typical store-front elevations

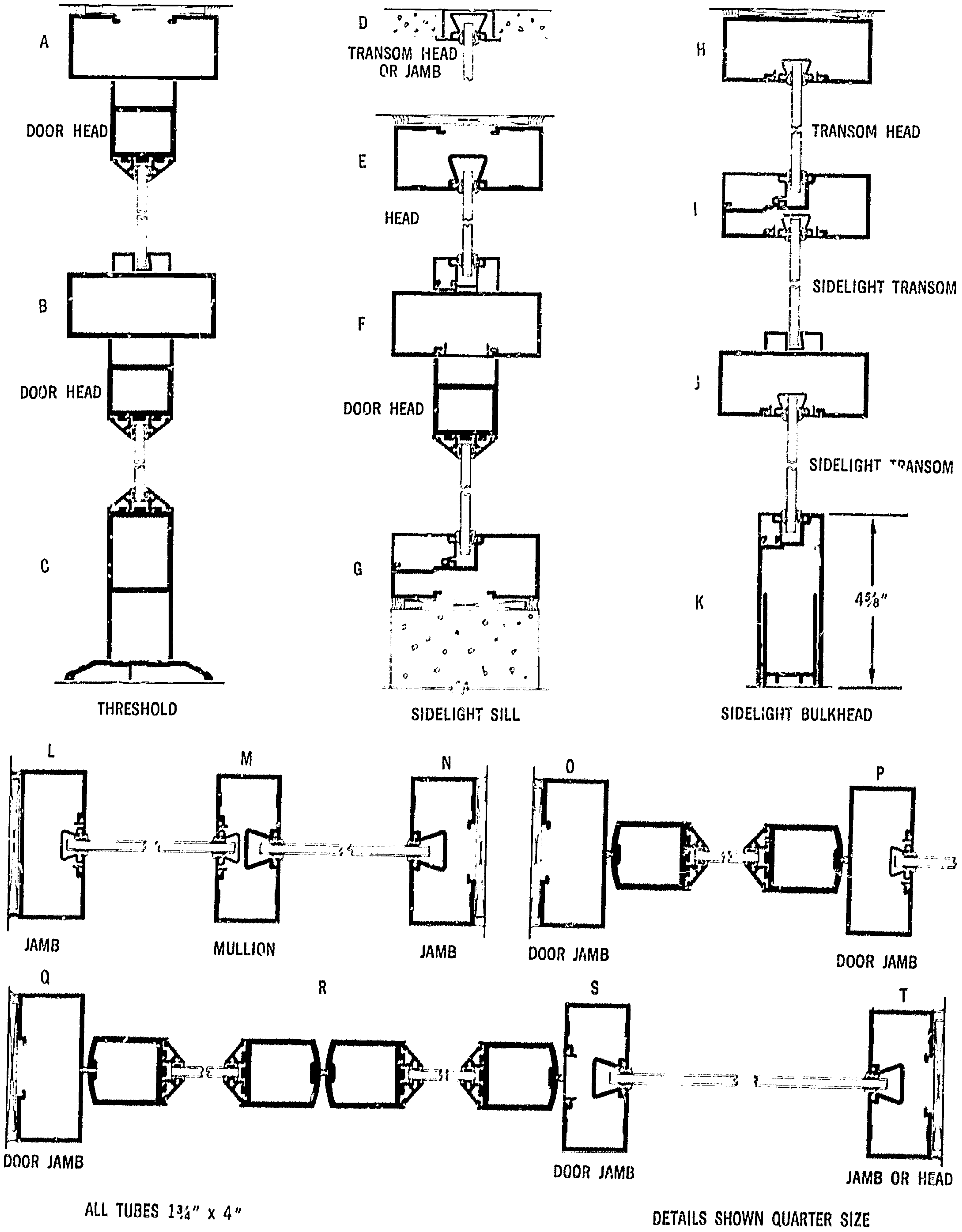
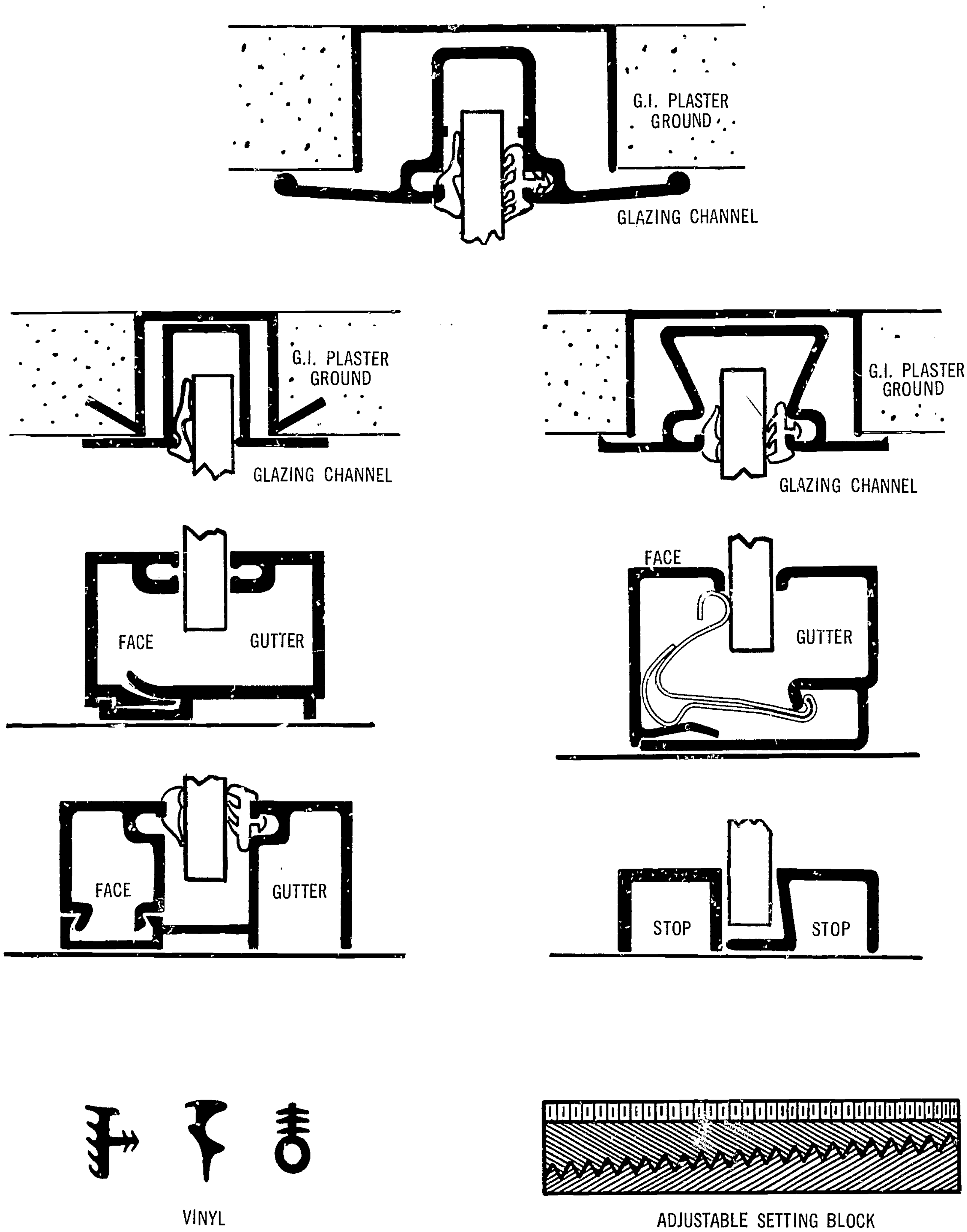
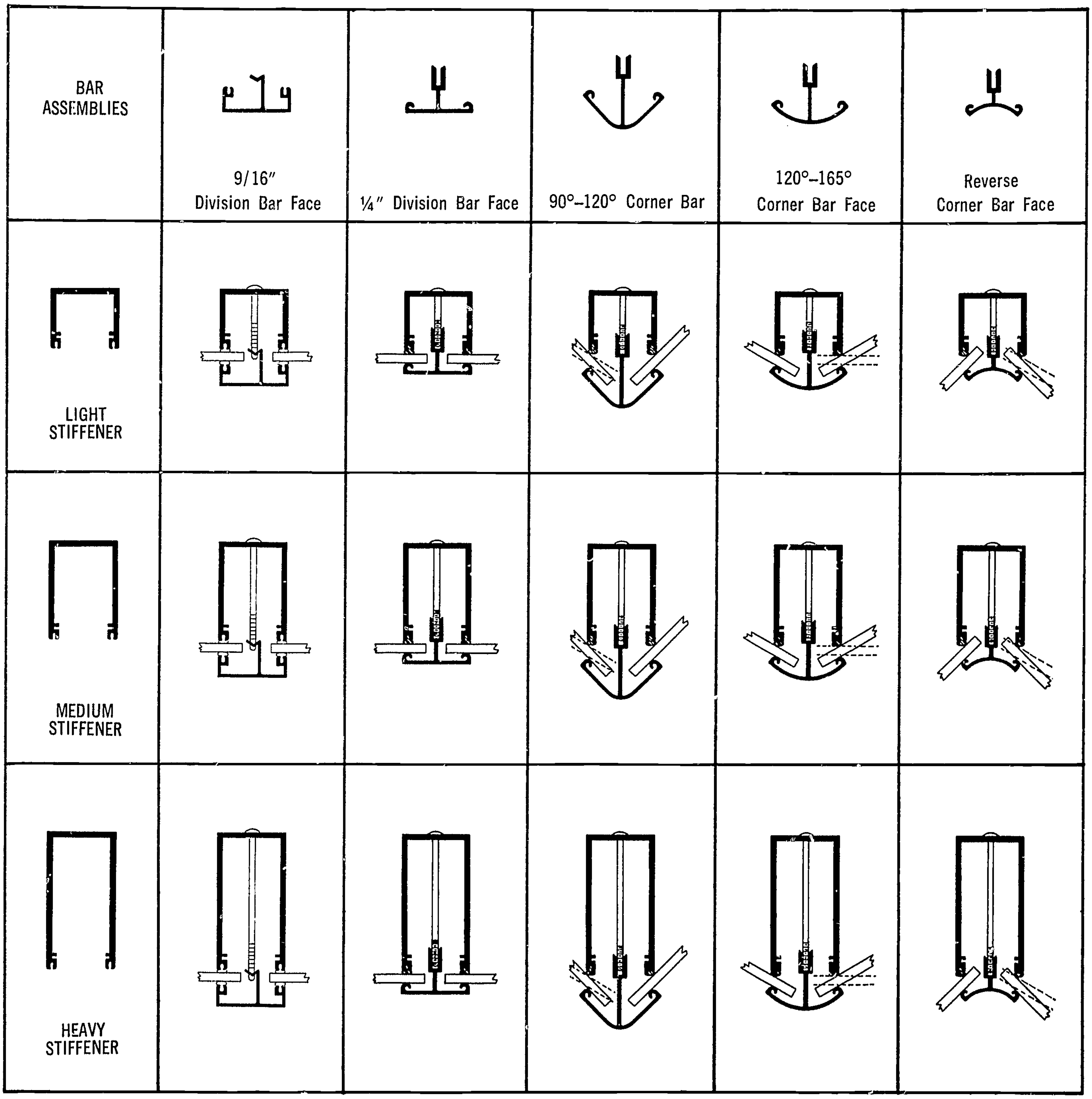


Fig. C-5. Typical metal details



DETAILS SHOWN FULL SIZE

Fig. C-6. Typical metal details



DETAILS SHOWN QUARTER SIZE

Fig. C-7. Typical corner and division bar details

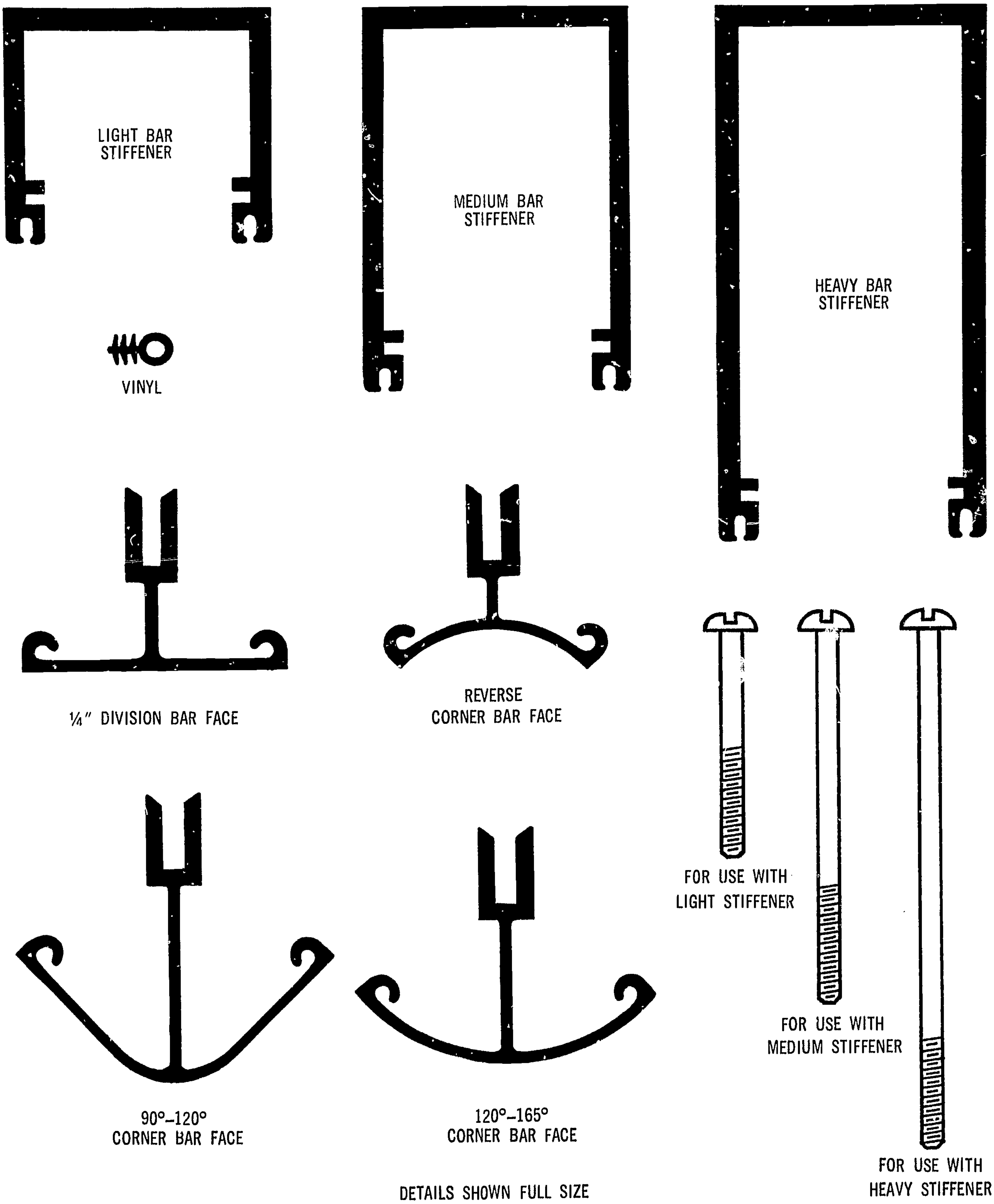


Fig. C-8. Typical corner and division bar details

UNIT C--APPLIED MATHEMATICS

TOPIC 2--METAL AND GLASS MEASUREMENTS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Accurate ___1___ information is essential if the glazier is to do a professional job. — 1. ____________

2. Glass must have a ___2___ around its perimeter between the glass edge and the inner face of the ___3___ ___4___. — 2. ____________ 3. ____________ 4. ____________

3. Heat-absorbing glass requires ___5___ edge clearance than plate glass. — 5. ____________

4. Glass penetration is slightly greater in ___6___ and ___7___ ___8___ than in division bars. — 6. ____________ 7. ____________ 8. ____________

5. The ___9___ reglet of the face member of a division bar may affect the requirement for depth of glass penetration into the bar. — 9. ____________

6. The more acute the angle of installation of glass into a corner bar, the ___10___ the glass penetration. — 10. ____________

7. The standard ___11___ glass coverage does not apply in every problem in glass measurement; ___12___ glass coverage requirements must therefore be taken into account in the calculation of glass sizes. — 11. ____________ 12. ____________

8. When a glass size is correctly developed, the dimensions will provide for adequate bite on the glass and room for ___13___ and ___14___ and will allow for ___15___ in glass and opening sizes. — 13. ____________ 14. ____________ 15. ____________

9. The minimum rabbet depth for a metal sash in which a 150 sq. ft. light of 1/4 in. plate glass is to be face glazed is ___16___. — 16. ____________

10. Greater tolerances may apply for ___17___ cut glass than for factory-cut glass. — 17. ____________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	The type of construction metal employed for an opening is a factor in determining the glass dimensions for the opening.	1.	T	F
2.	Glass measurements for flush-set tube installations require a tolerance of 15/16 in.	2.	T	F
3.	Glass requirements must be carefully adapted to the clearances and tolerances that apply in the particular installation.	3.	T	F
4.	Only standard sizes of glass are employed for metal openings.	4.	T	F
5.	An adjustable setting block provides a means for changing the size of a light of glass in an opening.	5.	T	F
6.	Setting blocks may not be needed in the installation of small lights of SS or DS window glass.	6.	T	F
7.	All installed glass requires edge clearance.	7.	T	F
8.	The same edge clearance can be employed for any standard size light of plate glass.	8.	T	F
9.	Factory tolerances for glass sizes make no allowance for flares.	9.	T	F
10.	At least 11/32 in. edge clearance at head, sill, and jambs should be allowed for a 200 sq. ft. light of 1/4 in. plate glass.	10.	T	F

UNIT C--APPLIED MATHEMATICS

TOPIC 3--DOOR OPENINGS

This topic, "Door Openings," is planned to help you find answers to the following questions:

- Why is accuracy especially important in making calculations for door installations?
- Why must pivot or hinge centers be accurately located and plumb?
- How does the incorporation of a threshold affect a store-front layout?

The measurements and calculations involved with door openings must be made with great accuracy. The clearances and tolerances that must be established at the time of installation must allow for movement of the door and thus are more critical than those for fixed installations. The subject of door openings should be studied with this requirement for high accuracy in mind.

The metal structure that frames the door opening, as well as the door or doors themselves, must be true and square, and jambs must be plumb. Great emphasis must be placed on the accurate location of the pivots or hinges. For example, the swing clearances seen in the door openings detailed in Figs. C-9 and C-10 can easily be lost if the pivot points are not accurately set. This becomes even more critical when the installation involves a pair of doors, as in Fig. C-10. The lateral dimension points of layout that establish the location of the checking devices in store-front work must therefore be very carefully determined and marked. If for example the pivot centers of the two checking devices in Fig. C-10 were not accurately located, the doors when installed would not have the correct clearance at the center. Careful attention should also be given to the relationship between the top and bottom pivot points of the door; if these two points are not on a plumb line, the door may drag when in the open position. In general, pivot centers are located 2-3/4 in. from the face of the jamb.

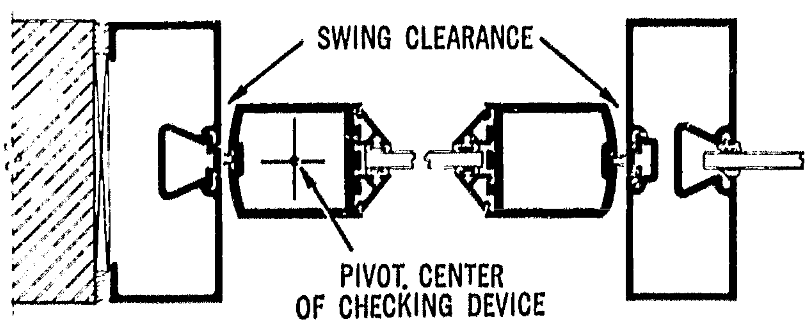


Fig. C-9. Opening with single door (details)

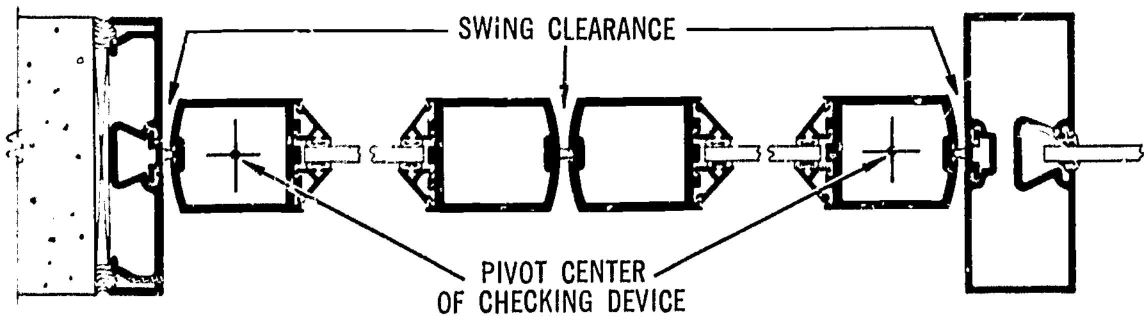


Fig. C-10. Opening with pair of doors (details)

The use of a threshold in the door opening has a marked effect upon the layout of an entire store front. Door panels are fixed in size, and if the installation includes a threshold, the transom bar is raised to permit the door to be installed with correct allowance for threshold clearance (Fig. C-11).

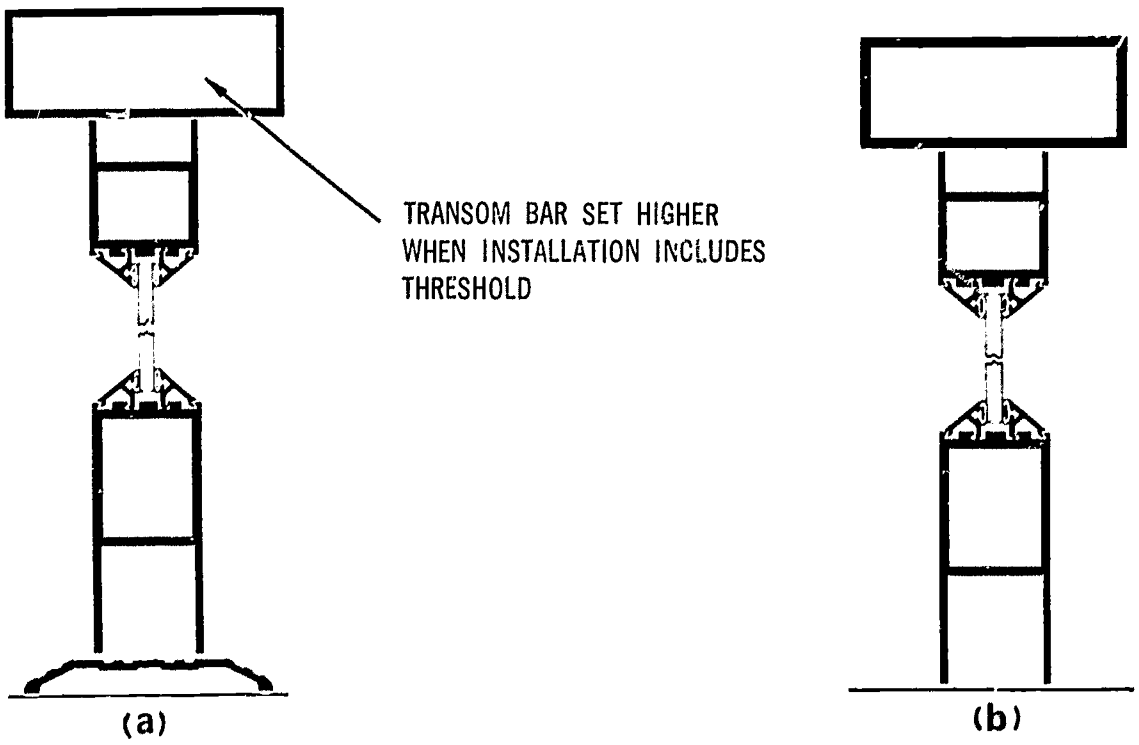


Fig. C-11. Door details with threshold (a) and without threshold (b)

The information that has been given in this topic will be of particular value to the glazier in store-front work, but it is also applicable to the installation of doors in general.

UNIT C--APPLIED MATHEMATICS

TOPIC 3--DOOR OPENINGS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The __1__ and __2__ involved with door openings must be made with great accuracy.	1. ________ 2. ________
2. The __3__ and __4__ relating to a door installation must allow for movement of the __5__	3. ________ 4. ________ 5. ________
3. The accurate location of __6__ or __7__ is very important in door installation.	6. ________ 7. ________
4. Correct swing __8__ must be provided if free movement of the installed door is to be assured.	8. ________
5. Pivot centers are usually located __9__ from the face of the __10__.	9. ________ 10. ________
6. The metal structure that frames the door opening must be __11__ and __12__.	11. ________ 12. ________
7. Top and bottom pivot centers must be __13__.	13. ________
8. The requirement for accurate layout in door installation is especially critical if the opening is to have a __14__ of __15__.	14. ________ 15. ________
9. Door panels are __16__ in size.	16. ________
10. The use of a __17__ affects the layout of the entire store front.	17. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Calculations relating to door openings may be of an approximate nature.	1.	T	F
2.	The required clearances and tolerances for the door action must be taken into account in the construction of the frame.	2.	T	F
3.	Measurements in door installations are more critical than those in fixed-light installations.	3.	T	F
4.	The measurements applied to butt-hinge installation and pivot installation are the same.	4.	T	F
5.	Swing clearances are important considerations at the time of pivot installation.	5.	T	F
6.	The installation of a threshold in a store-front door opening affects the height of the transom bar.	6.	T	F
7.	A pair of doors will have insufficient swing clearance at the center if the floor hinges are placed too close together.	7.	T	F
8.	The height dimension of the door must be reduced if a threshold is employed in the door opening.	8.	T	F
9.	If a door is not hung in a vertical plane, it will drag when it is opened.	9.	T	F
10.	Pivot centers are usually located 2-1/4 in. from the jamb face.	10.	T	F

UNIT D Blueprint Reading and Sketching

TOPIC 1--BLUEPRINTS AND THEIR USE

This topic, "Blueprints and Their Use," is planned to help you find answers to the following questions:

- In what ways are blueprints important in the building trades?
- What part do written specifications play in conveying the architect's intentions?
- How are lines of various types employed in architectural drawings?

Many individuals and groups of individuals cooperate to bring a new building to completion, and effective communication of information is essential in every phase of the project. The large amount of information needed by the builder must be put into compact, readable form. The architect performs this service by using what might be called the "language of drafting" to make working drawings, plans, or blueprints. He also prepares written specifications by means of which he is able to tell more about some items--materials and finishes, for example--than can be told conveniently on the drawings.

The Importance of Blueprints and Specifications

Blueprints and specifications must convey all the information necessary for the construction of a building and for the cost estimates that must be made in advance of construction. Whether the plans are for a large office building, a factory, or a residence, the same "language" is used, and the apprentice glazier therefore must begin as soon as possible to gain a thorough mastery of that language.

A competent glazier, like any other craftsman in the building trades, must know how to get the information he needs from a set of drawings and specifications. A thorough knowledge of blueprint reading will enable him not only to visualize how the building will look when it is completed, but also to determine the size, shape, and location of all glass to be installed; the types, sizes, and lengths of all metals to be used in the construction of frames and store fronts; and the types and size of the staging and scaffolding necessary to complete the job.

Specifications are written statements outlining such items as the kinds and grades of materials to be used, the standards of workmanship to be followed, and the time limit given for the completion of the contract. They are usually supplied separate from the drawings in the form of a typewritten booklet.

The Language of Blueprints

It would be impossible to describe any proposed building by words alone. The development of the art of drafting has provided the construction industry with a more efficient means for transmitting ideas. A complete set of plans and specifications can be mailed to any location, and a building can be constructed from them without the exchange of a word between the designer and the builder. All the required information can be obtained from such a complete set, and a mechanic with a sound knowledge of the language of blueprints can visualize every bit of information shown on the drawings.

Several types of lines are employed in architectural drawings; some lines are thicker than others, some are solid, and some are broken. Each type of line has a specific meaning. Some of the more common types of lines, with an example of their application, are shown in Fig. D-1. Symbols and conventions, which are also part of the language of blueprints, will be studied in future assignments.

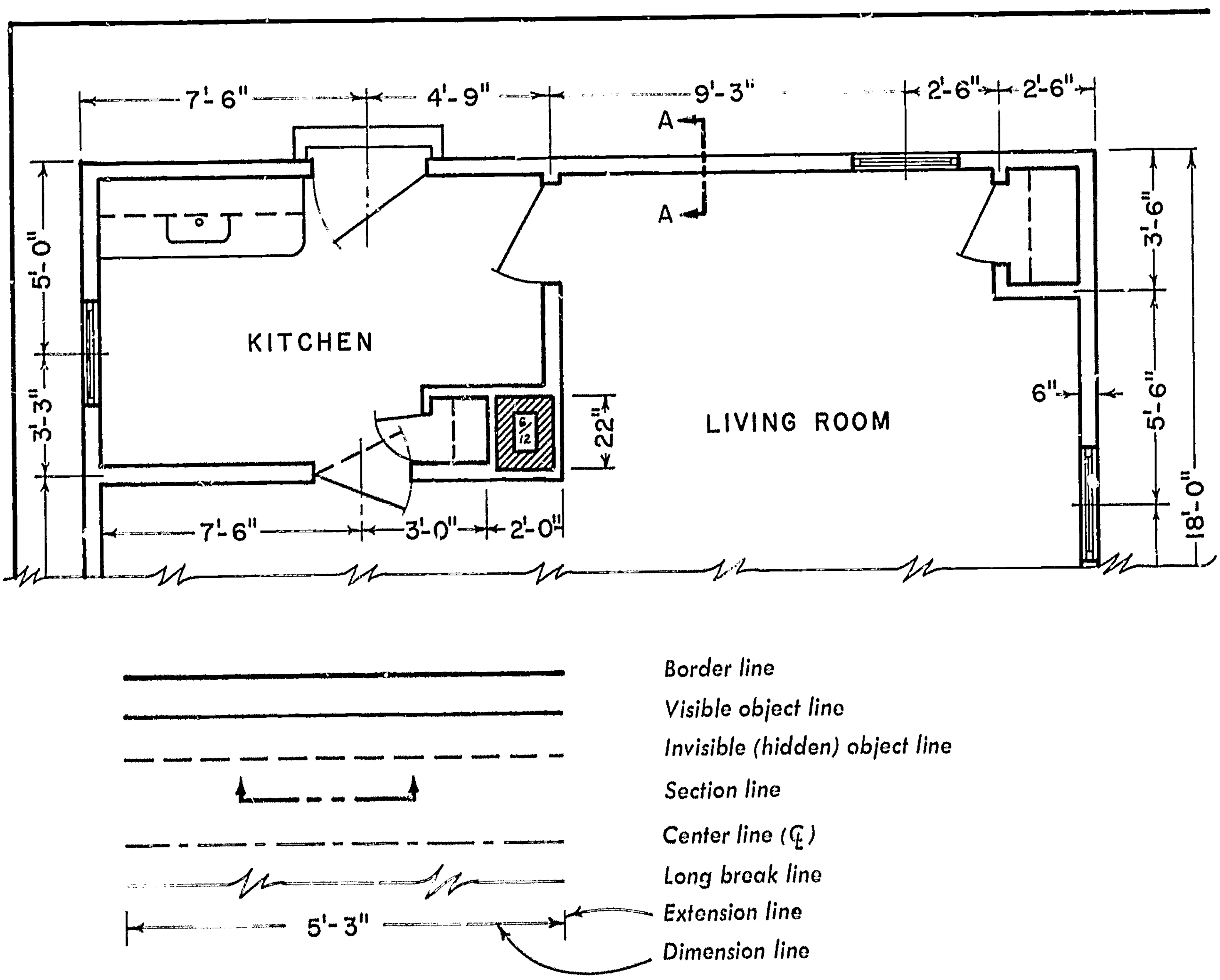


Fig. D-1. Blueprint lines

Preparation of Blueprints

In the past, it was considered necessary to ink all drawings, but today satisfactory blueprints are made by using a comparatively soft pencil and by drawing directly on tracing paper. The blueprints are produced from the pencil drawings by a process resembling that for the printing of photographs. In most cases today, blueprints are made by means of a blueprinting machine.

Many copies of each drawing are needed because many different tradespeople use them. As soon as the architect has completed the plans and specifications, they must be made available to contractors and subcontractors for preparation of their bids for a job or their estimates of total cost. The complications that would result if the blueprints were not complete or if all sets were not identical can be appreciated readily.

Building designs must be approved by the building inspection department and checked for compliance with the building code and zoning ordinances before building permits may be obtained. For this purpose, a set of plans must be filed with the building inspector. This requirement protects the general public and the property owners in the locality.

If a loan is necessary in the financing of the project, plans must also be approved by the lending agency. Finally, of course, a complete set of plans and specifications is needed on the job as a guide for the builders.

Study Assignment

J. Ralph Dalzell, Building Trades Blueprint Reading: Part 1--Fundamentals. Chicago: American Technical Society, 195[illegible] Read pp. 5 and 6, "Introduction to Working Drawings."

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 1--BLUEPRINTS AND THEIR USE - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Complete information for the construction of a building is obtained from the __1__ and __2__.	1. ______ 2. ______
2. Plans for a building are drawn by the __3__ and are made available to __4__, who then submit bids for the job.	3. ______ 4. ______
3. The heaviest line on a blueprint is the __5__ line; next to it in thickness is the __6__ __7__ line.	5. ______ 6. ______ 7. ______
4. Objects concealed from the eye are shown by means of __8__ __9__ lines.	8. ______ 9. ______
5. A line consisting of alternating long and short dashes is a __10__ line.	10. ______
6. Specifications contain information concerning kinds of __11__, __12__ of workmanship, and contract completion __13__.	11. ______ 12. ______ 13. ______
7. Before work on a building can be started a(n) __14__ must be obtained from local authorities, and this requires that a set of plans be filed with the local __15__ __16__ department.	14. ______ 15. ______ 16. ______
8. Copies of the set of plans are also needed by the __17__ and __18__ for the preparation of __19__, by the __20__ agency if a loan is necessary, and on the job for the guidance of the __21__.	17. ______ 18. ______ 19. ______ 20. ______ 21. ______
9. Specifications are usually supplied in the form of a __22__ __23__.	22. ______ 23. ______
10. Blueprints are made by a process similar to that employed for printing __24__.	24. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Ability to read very simple drawings is adequate for an apprentice in a technical subject.	1.	T	F
2. Standards of workmanship relating to the glazier's work may appear in the specifications for a new building.	2.	T	F
3. To determine the required standards of workmanship for glazing in a new building, the mechanic should refer to the blueprints showing the installation.	3.	T	F
4. Cost estimates for the required glass work for a new building can be made from information given in the specifications.	4.	T	F
5. Dimension lines, break lines, center lines, and extension lines are all light lines.	5.	T	F
6. The border line is the heaviest line on a blueprint.	6.	T	F
7. The border line indicates the outline of the object.	7.	T	F
8. The information given in the blueprints aids the glazier in the selection of staging and scaffolding needed for the job.	8.	T	F
9. A drawing need not be inked to ensure the production of clean blueprints.	9.	T	F
10. Most blueprints are produced by means of blueprinting machines.	10.	T	F

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 2--ELEVATION VIEWS

This topic, "Elevation Views," is planned to help you find answers to the following questions:

- What is an elevation view?
- What information about the building is given in the elevation views?
- What are working drawings, and where are they used?

The Importance of Elevation Views

Elevation views (often called simply "elevations") make up an important part of the glazier's working drawings. An elevation view represents that part of a building seen by an observer standing directly in front of one of its sides or faces. Like other working drawings, an elevation view shows the object in true proportion; in other words, no perspective is employed. Depending upon the face of the building shown, the view is called a north, south, east, or west elevation to designate it clearly. The elevation views show the various types of glazing that apply to the building, whether it be a relatively simple one-story structure or a structure many stories high.

Architectural Symbols

Architectural symbols--standardized representations of materials such as glass, metal, masonry, wood, and so forth--are employed in the preparation of architectural drawings to simplify and make uniform the "language" of the drawings. Each symbol is drawn to look nearly like the material or detail it represents. These symbols on the elevation views provide the various building trades with a great deal of information concerning the exterior parts of a building. They help the glazier determine the location, types, and sizes of such items as store-front entrances, openings on side elevations for aluminum frames and glass installations, wood doors with glass, and aluminum-framed sliding glass doors, as well as curtain-wall and window-wall construction of aluminum or steel sash.

Working Drawings

The term "working drawings" is used to describe those drawings--floor plans, elevations, sections, details, and so forth--that are used by the builder and the various crafts in bringing a new building to completion. Working drawings are also known to some of the people in the building trades as "shop drawings." Shop drawings also include drawings that are made up by individual manufacturers and suppliers of items and materials used in the construction industry--metal extrusions and curtain-wall structures, for example. Shop drawings present the needed information in a more compact and accessible form than the larger,

more complicated, complete set of architectural drawings upon which they are based. Although he may occasionally need to refer to the complete set of architectural drawings, the tradesman will be concerned primarily with the working drawings for his particular trade, which are used wherever possible in place of the bulkier and hence less usable complete architectural set.

Three sets of working drawings, showing selected features and glazing details of a church, a bank, and a shopping center, have been included following Topic 6 of this unit (Plans 1-10). The value of elevation views to the glazier will be evident from an examination of these typical working drawings. The various elevation views locate and indicate sizes of doors and windows; provide door, window, and hardware schedules; include written notes and certain specifications; and are keyed to detail drawings by means of circled reference numbers. Although the drawings in each case have been reduced to book page size for convenient inclusion in the workbook, it can be seen that the elevations were drawn to scale. The details for the most part were drawn to size. Detail drawings, which are keyed by numbers to related numbered locations on elevations and other working drawings, are very helpful to the mechanic in that they allow for close tolerance in measurements and clearly indicate joinery methods, sizes of anchorage, and other construction details. Detail drawings will be studied in a later assignment.

The finish of the extruded aluminum construction materials is also specified on the elevation drawings; the finish of the material for the bank job is to be "Permanodic 28" (a trade-mark designation of the Kawneer Company for a bronze finish), while the materials for the other jobs are to be of a certain grade aluminum finish. Modern aluminum extrusions for window-wall, curtain-wall, and store-front construction can be finished to almost any shade and color to meet the requirements of the architect.

Study Assignment

<u>Building Trades Blueprint Reading: Part 1--Fundamentals.</u>

1. Read pp. 7-9, 13-15, and 21-24; study all the drawings carefully using the self-check quiz as a study aid.

2. Study the elevation symbols found in the illustration on p. 122.

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 2--ELEVATION VIEWS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, check your understanding of the topic by completing the following exercises in Building Trades Blueprint Reading: Part 1--Fundamentals:

1. Answer the questions for Trade Competency Test No. 1, p. 11.
2. Answer the questions for Trade Competency Test No. 2, p. 17.
3. Answer the questions for Trade Competency Test No. 3, pp. 27 and 28.

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The glazier works directly from the complete set of architectural drawings.	1.	T	F
2. The location and sizes of doors and windows can be determined from an examination of a building's elevation views.	2.	T	F
3. Compass directions may be employed to designate elevation views.	3.	T	F
4. Architectural symbols are part of the language of drafting.	4.	T	F
5. Shop drawings are working drawings.	5.	T	F
6. Symbols are seldom employed in elevation drawings.	6.	T	F
7. Shop drawings are in every case drawn by the architect or his draftsman.	7.	T	F
8. All the information needed by the glazing contractor will be found on the shop drawings.	8.	T	F
9. Elevation views are drawn to scale.	9.	T	F
10. The finish required for store-front metal may be specified on an elevation view.	10.	T	F

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 3--PLAN VIEWS

This topic, "Plan Views," is planned to help you find answers to the following questions:

- What is a plan view?
- What information of importance to the glazier is given in a floor plan?
- How are plan views and elevation views related?

In the foregoing topic, it was shown that elevation views are scale drawings employed to represent the exterior parts of houses and buildings and that the draftsman employs symbols, terms, and abbreviations to indicate various types or kinds of materials and structural parts. A study of representative working drawings showed that elevation views are of great value in helping the workmen visualize the materials and external features specified for the building by the architect. Another kind of working drawing, the plan view, will now be discussed.

The Importance of Plan Views

Elevation views include important information, but they alone are not sufficient to portray a new building; plan views are also essential for this purpose. When the apprentice has learned to read and visualize plan views and to relate them to elevation views, he will have improved his ability to read blueprints to a point that will permit him to visualize both the interior and exterior features of a proposed building.

Floor Plans

A set of related drawings or blueprints is commonly referred to as a set of plans, but the term "plan" may be used in another way: in this other sense, a "plan" is a drawing that shows the arrangement of rooms on one floor of a house or building. Such a drawing is called a floor plan. If a building has more than one floor, each floor is represented by a separate plan that is named according to the floor it represents. To visualize a floor plan, one can imagine that the house has been cut in half horizontally to permit a view down into it from above; this is a plan view. Other types of plan views--plot plans, foundation plans, and roof plans, for example--will not be considered in this topic.

A floor plan will be found among the working drawings following Topic 6 of this unit. This plan view (Plan 4) is reproduced from the set of architectural drawings for a church. The arrow on the drawing indicates north, establishing the orientation of the building and making it possible to relate the various elevation views to the floor plan. Examination of the plan reveals that the entrance of the church faces west and that the entrance and the vestibule together require six pairs of doors, all of which in this case swing out.

Plan views, like elevation views, are drawn to scale and are picture-like representations employing symbols, terms, and abbreviations to indicate materials and structural parts.. A close study of the floor plan of the church will reveal a great many construction details and written specifications of interest not only to the glazier but to workers in all crafts participating in such a construction project.

Study Assignment

Building Trades Blueprint Reading: Part 1--Fundamentals.

1. Read pp. 29-35, 39, 43, and 44.
2. Study the abbreviations listed on pp. 44-46. Check those that you believe would be particularly important to a glazier.
3. Study the drawings on pp. 39-41. Be sure to read all the explanations that accompany the drawings.
4. Study the symbols for plan views given in the illustration on p. 122.
5. Answer the questions in the self-check quiz, p. 49; check your answers on p. 50.

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 3--PLAN VIEWS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, check your understanding of the topic by completing the following exercises in Building Trades Blueprint Reading: Part 1--Fundamentals:

1. Answer the questions for Trade Competency Tests No. 4 and No. 4A, pp. 37 and 38.

2. Answer the questions for Trade Competency Test No. 5, pp. 53 and 54.

Test

Read each statment and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Plot plans, foundation plans, floor plans, and roof plans all come under the category of plan views.	1.	T	F
2. Plan views are drawn primarily to outline the perimeter of a building.	2.	T	F
3. Plan views and elevation views give essentially the same information about a building.	3.	T	F
4. Shop drawings for the construction glazier always include a plan view.	4.	T	F
5. The symbols employed in plan views are very much like those employed for elevation views.	5.	T	F
6. Plan details are identified by numbers in the same manner as elevation details.	6.	T	F
7. Plan views have little or no relationship to elevation views.	7.	T	F
8. The various floor plans for a multistory building are identified in accordance with the floor each plan represents (First Floor Plan, Second Floor Plan, and so forth).	8.	T	F
9. To visualize a floor plan, one can imagine a building cut horizontally in half and then can view the bottom half from above.	9.	T	F
10. An arrow symbol indicating north will be found on a main floor plan.	10.	T	F

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 4--DETAIL VIEWS

This topic, "Detail Views," is planned to help you answer the following question:

- What is a detail view?
- What are the two general classes of detail views, and what are the characteristics of each class?
- What kinds of information are conveyed by means of detail views?
- How are detail views related to other types of working drawings?

The architect makes use of several types of views to present clearly the many kinds of information required in a set of architectural plans. In addition to elevation views and plan views, he includes structural, sectional, and detail views in the set of drawings for the proposed building. Detail views--drawings that show selected features or parts of the building in greater detail than would be poss 'ble with other types of views--will now be discussed.

Detail views, like other working drawings, are picture-like representations in which terms, abbreviations, letters, and numbers are employed to convey information about the building in a compact form. Elevation views and plan views are for the most part drawn to a relatively small scale, but detail views are usually drawn to a much larger scale, or even full size, and on separate sheets. A detail view must be drawn large enough to ensure that it will be clearly understood, for it must convey to the mechanic, not only the structural design of the object represented, but also the purpose and method of applying and joining its structural and mechanical parts.

Detail views may be divided into two classes--the placement class and the assembly class--according to their intended purposes. If the primary purpose of the detail view is to indicate the placement of items such as cabinets, fixtures, machinery, and the like, it will be of the placement class, usually taking the form of a plan or elevation drawing. Detail drawings of the assembly class, which are of greater interest to the glazier, illustrate the arrangement and relationship of the parts of the object or structure represented. An assembly detail drawing may take the form of an interior or exterior elevation view, a plan, a sectional cut, a cutaway drawing, or some combination of these types of views. It may consist of a single detail, or it may combine two or more details in one drawing.

Detail drawings are designated by numbers or letters for identification, arrangement, and reference. The identifying number or letter permits the reader to relate the detail drawing to elevations, plans, and other working drawings and thus helps him to visualize the detail in its relationship with the larger object or structure of which it is a part.

A study of the working drawings included following Topic 6 of this unit will reveal the value of detail drawings and their relationship to other working drawings. For example, the circled numbers appearing at many places throughout the plan and elevation views of the church (Plans 1, 2, and 4) are keyed to numbered detail drawings (Plans 2 and 3) included in the set. The construction at the locations designated by the circled number 2 on the east and west elevation views (Plan 1) is shown in detail drawing No. 2 on Plan 2. This cut-through or sectional detail illustrates several actual details of importance in the construction of this front. Note that the full-size detail also gives the manufacturer's catalog numbers for the structural materials shown.

In the west elevation shown on Plan 1, the door features designated by the circled number 3 are shown in full-size detail in detail drawing No. 3 on Plan 2. By means of a vertical section, this detail makes clear the structural design of the bottom rails of each of the three pairs of entrance doors and indicates that a threshold and a weather strip are included in the construction.

The floor plan of the church (Plan 4) shows that the entrance includes a vestibule and a second set of three pairs of doors. An elevation-type detail view of the vestibule entrance will be found on Plan 2. The difference between the set of entrance doors and the set of vestibule doors will be made clear from a careful study of the related drawings.

Plans 5-7 are working drawings showing glazing features of a bank. Four of the five elevation views that make up Plan 5 show doors. The dotted lines on each door, extending from the upper and lower corners and meeting at the center of one side, serve to indicate the side the door is hinged on. Here again, circled detail numbers at many places on the elevation views relate to similarly numbered details on separate sheets (Plans 6 and 7). Details 8 and 9 on Plan 7 indicate that the doors shown on all but one of the elevations are center hung; details 10 and 11 indicate that the door shown in the south elevation (courtyard) is offset hung. Each of these methods of hanging and hinging a door calls for a type of hinge that is manufactured to meet its special requirements.

Additional examples of the use of detail views in a set of working drawings will be found in the drawings for a shopping center (Plans 8-10) included following Topic 6 of this unit.

Study Assignment

Building Trades Blueprint Reading: Part 1--Fundamentals, pp. 71-91.

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 4--DETAIL VIEWS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Detail views show selected __1__ or __2__ of a building in detailed form.	1. ________ 2. ________
2. A detail view illustrates an object's structural design and the __3__ and __4__ of applying and joining its structural and __5__ parts.	3. ________ 4. ________ 5. ________
3. A detail view must be drawn large enough to ensure that it will be __6__ __7__.	6. ________ 7. ________
4. A detail drawing of the __8__ class serves mainly to indicate the location of cabinets, fixtures, machinery, and the like in the building.	8. ________
5. A detail drawing of the __9__ class serves to illustrate the arrangement and relationship of the parts of an object or structure.	9. ________
6. Detail drawings, like other working drawings, are __10__ representations that employ symbols, __11__, abbreviations, __12__, and __13__ to convey information.	10. ________ 11. ________ 12. ________ 13. ________
7. Detail drawings are designated by __14__ or __15__ for identification, arrangement, and reference.	14. ________ 15. ________
8. Trim details are usually drawn __16__ scale.	16. ________
9. A detail view may consist of two or more __17__ in one drawing.	17. ________
10. Assembly-class detail drawings may take the form of interior or exterior __18__ views, __19__ views, __20__ cuts, __21__ drawings, or some combination of these types of views.	18. ________ 19. ________ 20. ________ 21. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Detail views are picture-like representations that take the place of symbols.	1.	T	F
2. Details are usually drawn to a large scale or full size.	2.	T	F
3. An illustration of a cut-through section of a transom bar is an example of a placement-class detail drawing.	3.	T	F
4. Details are drawn primarily to clarify elevation views.	4.	T	F
5. A sectional view of a wall shows interior details, and it therefore may be called a detail view.	5.	T	F
6. Sectional and cutaway details include information relating to the joining of structural parts.	6.	T	F
7. Details are usually grouped together and shown on separate sheets of the working drawings.	7.	T	F
8. Details are not a part of shop drawings.	8.	T	F
9. A detail view illustrating the location of kitchen cabinets on an interior elevation is an example of a placement class detail drawing.	9.	T	F
10. Detail drawings of store front metal contain information of value in determining glass sizes for the installation.	10.	T	F

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 5--SCALES AND DIMENSIONS

This topic, "Scales and Dimensions," is planned to help you find answers to the following questions:

- What is meant by the phrase "drawing to scale"?
- What is an architect's scale, and how is it used?
- How are dimensions taken from a drawing?
- What dimensioning standards and styles are used in the making of working drawings?

A thorough understanding of scales and dimensions is essential to the correct reading of blueprints. A careful study of this important assignment will reveal how the architect scales and dimensions working drawings and will thus give the apprentice a clearer understanding of the information presented on blueprints.

Sometimes it is necessary to determine a missing dimension by scaling directly from the drawing. Because blueprint paper may shrink or change its shape in other ways, it is wise in such a case to check the missing dimension with the architect if it is one which must be accurate to very close limits.

Study Assignment

Building Trades Blueprint Reading: Part 1--Fundamentals. Read pp. 57-64. Answer the questions in the self-check quiz on p. 65; then check your answers on p. 66.

UNIT D--BLUEPRINT READING AND SKETCHING

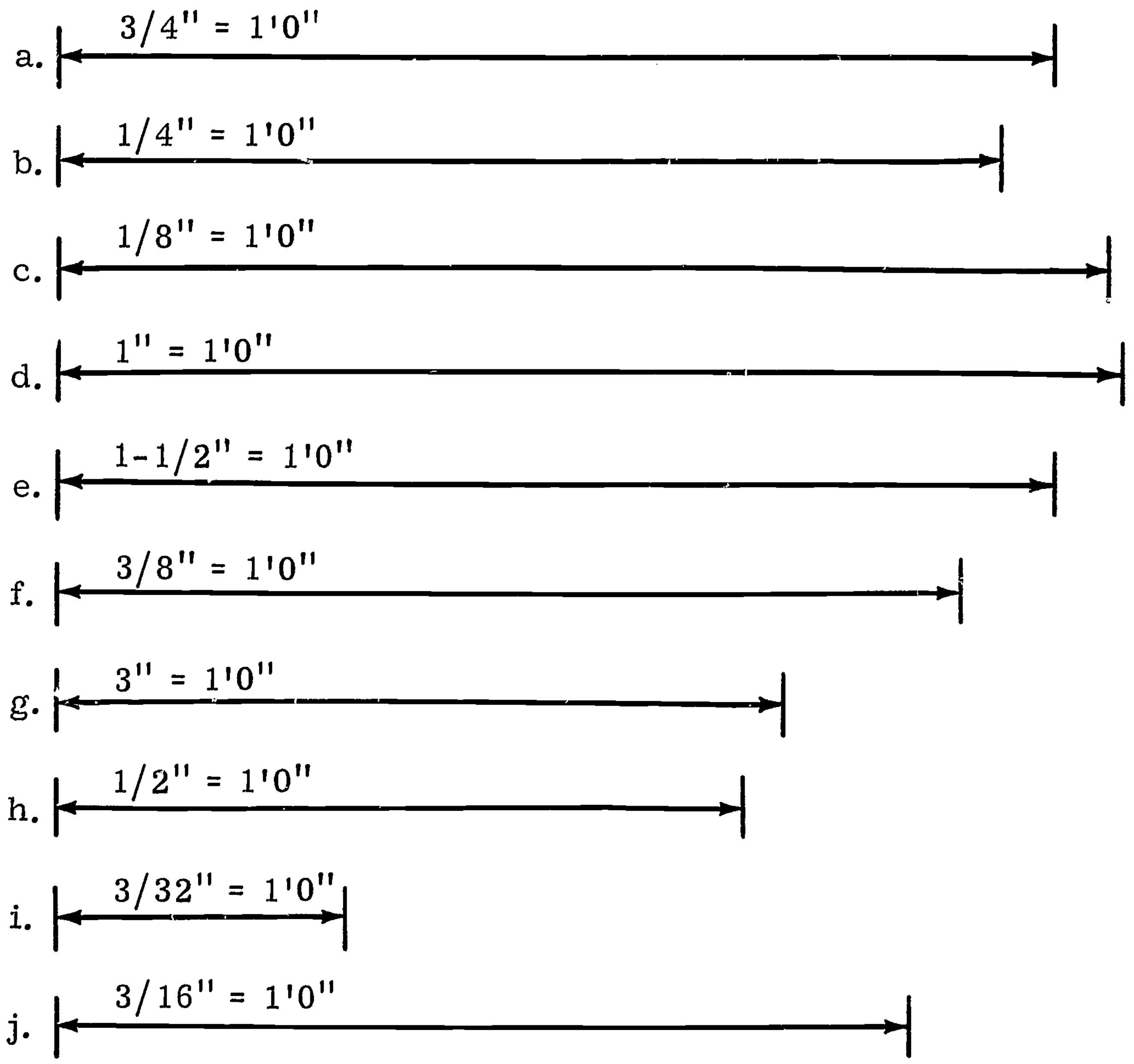
TOPIC 5--SCALES AND DIMENSIONS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, check your understanding of the topic by performing the following:

1. Answer the questions for Trade Competency Test No. 6 in <u>Building Trades Blueprint Reading: Part 1--Fundamentals</u>, p. 69.

2. Scale the lines in the following exercises. Each line is drawn to a different scale, as shown. In each exercise, write the full-size length of the line at the right in the space that has the same letter as the exercise.



a. ______
b. ______
c. ______
d. ______
e. ______
f. ______
g. ______
h. ______
i. ______
j. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. An object drawn to scale is shown in its true proportions.	1.	T	F
2. Two or more scales may be employed for different parts of the same drawing.	2.	T	F
3. Several different scales may be employed in a complete set of blueprints.	3.	T	F
4. If a dimension that must be determined within very close limits is not shown on a drawing and cannot be calculated, it should be scaled directly from the drawing.	4.	T	F
5. The dimensioning standards employed for drawings vary from area to area and according to the preferences of architects and draftsmen.	5.	T	F
6. Extension lines and dimension lines are thin, solid lines.	6.	T	F
7. An architect's scale is more convenient than a common ruler for scaling a drawing.	7.	T	F
8. The smallest scale on an architect's scale is labeled 1/8.	8.	T	F
9. In a floor plan drawn to a scale of 1/4"=1'0", a partition 6" wide would be represented by parallel lines spaced 1/8" apart.	9.	T	F
10. Dimension lines are always terminated by arrows.	10.	T	F

UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 6--SKETCHING

This topic, "Sketching," is planned to help you find answers to the following questions:

- Why is skill with sketching useful to a worker in the building trades?
- What are the techniques of freehand sketching?
- What method of drawing most nearly portrays an object as it would appear to the eye of the observer?
- What method of drawing is used to produce working drawings?

Freehand sketching is useful to workers in almost every occupation, in all trades and all industries. It is a way of conveying ideas rather than a method of making perfect, completed drawings. By means of one or more freehand sketches, the many parts of an assembly can be described clearly and adequately, or the essential ideas in more complex drawings can be brought together.

Learning to sketch is of benefit to the apprentice in still another way. If he makes a habit of sketching the objects he wishes to describe, he will notice improvement in his power of accurate observation; an object must be studied carefully if it is to be sketched accurately.

Types of Sketches

Architectural sketches may be divided into two general classes. The first class includes the sketches made in connection with the designing of the structure, such as preliminary layouts, which represent schemes or ideas used in studying and developing the arrangement and proportion of the parts. An example of this first class of architectural sketches would be a rough floor plan, showing the sizes of rooms to be arranged in developing a well proportioned house plan.

The second class includes detail sketches, usually developed from sketches of the first class, but detailed to give type of materials, size of fastenings, dimensions, and other necessary information.

Materials for Sketching

The only materials necessary for sketching are pencils, a pencil eraser (preferably soft), and paper--a notebook, a pad, or a single sheet clipped to a board. Pencils should be kept sharpened to long conical points, with plenty of lead showing. Fine sandpaper should be used to touch up the points as they wear down. Two pencils are needed--one of fairly hard lead (H or 2H) for blocking in the outlines and one of soft lead (HB or 2B) for finishing the work.

Drawing should not be done with a blunt or stubby-pointed pencil. The sharpness of the pencil point influences line weight: a fine point produces a fine line and a blunt point a heavy line.

Scales and Measuring

Before any sketch is drawn, measurements should be laid out. A flat rule or a triangular scale may be used for this purpose, but an architectural scale is best for architectural sketching. Sketches are not drawn to exact scale, but they should be made so that the objects shown are in proper proportion to each other. Sometimes finely ruled paper may be used to simplify proportioning.

Sketching Lines Freehand

The development of correct skills in sketching lines freehand is more important than speed for the beginner. Drawing should always be done with light, firm strokes preventing uncertain lines. The pencil should be held 3/4 inch to 1 inch from the point so that the lines to be drawn are not obscured by the fingers and so that there is a free and easy movement of the pencil. A free arm movement makes it possible to sketch smoother, neater lines than the rough and inaccurate lines produced by a finger and wrist movement. The mechanic should try to control the smoothness and weight of the lines, but accuracy of direction is the most important factor here.

The three types of straight lines used in drawing and sketching are horizontal, vertical, and oblique (sometimes called slant or inclined). All vertical lines should be drawn in one direction--toward the body. Horizontal lines should be drawn from left to right. Oblique lines running from right to left are drawn as are vertical lines, but oblique lines running from left to right are sometimes more difficult to execute; it is advisable to turn the paper and draw them as horizontal lines.

An important technique to learn in drawing straight lines is to keep the eye on the point to which the line is to go, not on the pencil point. Short, overlapping strokes should be used; the entire line should not be attempted in a single stroke.

Basic Forms in Sketching

In sketching most objects, one or more of certain basic forms--squares, rectangles, triangles, circles--will be employed. Some of the easiest methods of drawing these fundamental shapes are described in the following paragraphs.

Squares and rectangles. To sketch a square, two lines should be laid out at right angles to each other and equal distances marked off on each from the center point where they cross. Then the square should be sketched in accordingly. (See Fig. D-2.) A rectangle is laid out in a similar way, except that shorter distances are marked off for the shorter sides of the rectangle.

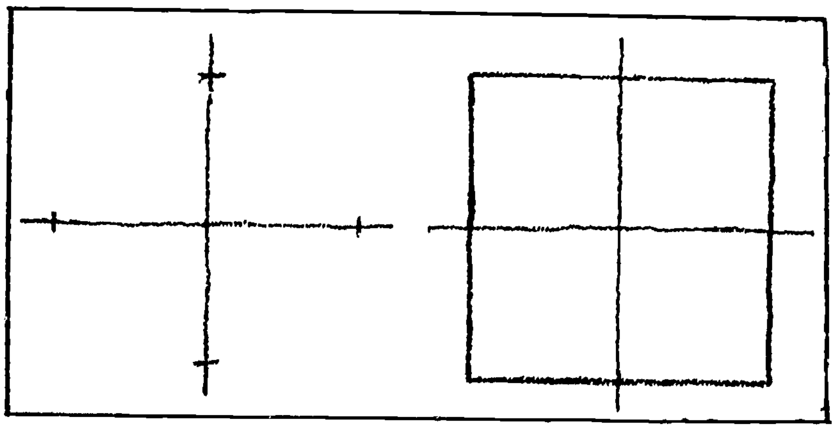


Fig. D-2. Sketching a square

Circles. To sketch a circle, intersecting vertical and horizontal lines should be drawn first, then two oblique lines that will cut each quarter of the circle in half. Equal distances should be marked out from the center on each of the lines and the arcs drawn between the marks. (See Fig. D-3.)

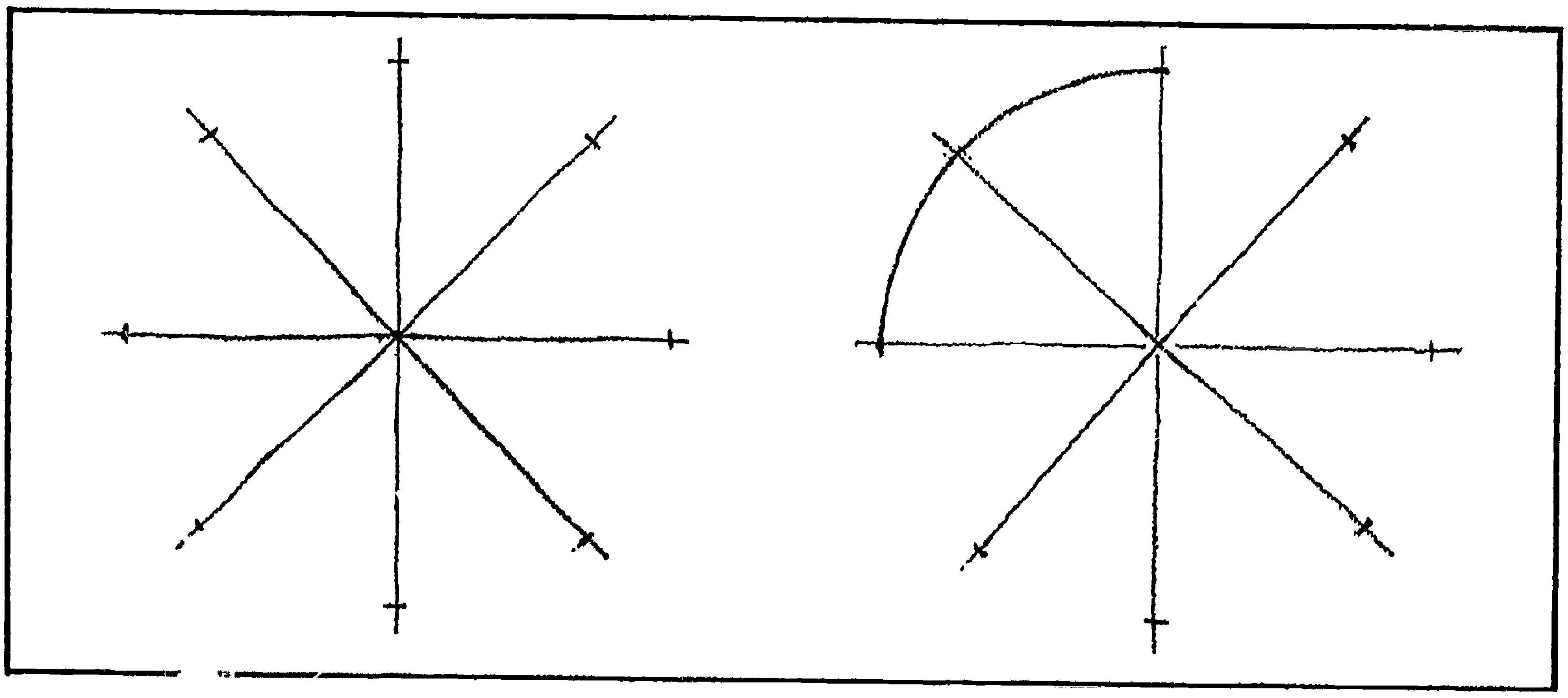


Fig. D-3. Sketching a circle

Triangles. A right triangle can be sketched by first drawing a vertical and a horizontal line to intersect and then laying out the proper distance along each. Other triangles can be sketched by laying out part of a circle as in Fig. D-3 and dividing it so that the angle of the radial lines corresponds to the angle to be drawn; or a protractor can be used, if one is at hand.

Methods of Drawing

Two general methods of drawing--pictorial drawing and orthographic projection--are widely used in the building trades. Pictorial drawings, which show objects more or less as they would appear to a person viewing them, are the easiest type to understand. Various methods of pictorial drawing have been developed; each has advantages and disadvantages, both in ease of drawing and in the clarity of results.

Oblique drawing. One method of pictorial drawing, called "oblique" drawing, involves drawing one side or view of the object on a horizontal base line--that is, directly facing the viewer--then drawing the adjacent side and the top at an angle of 30°, 45°, or 60° with this line. This method portrays the object in a distorted way, since all lines are drawn to scale. (See Fig. D-4.)

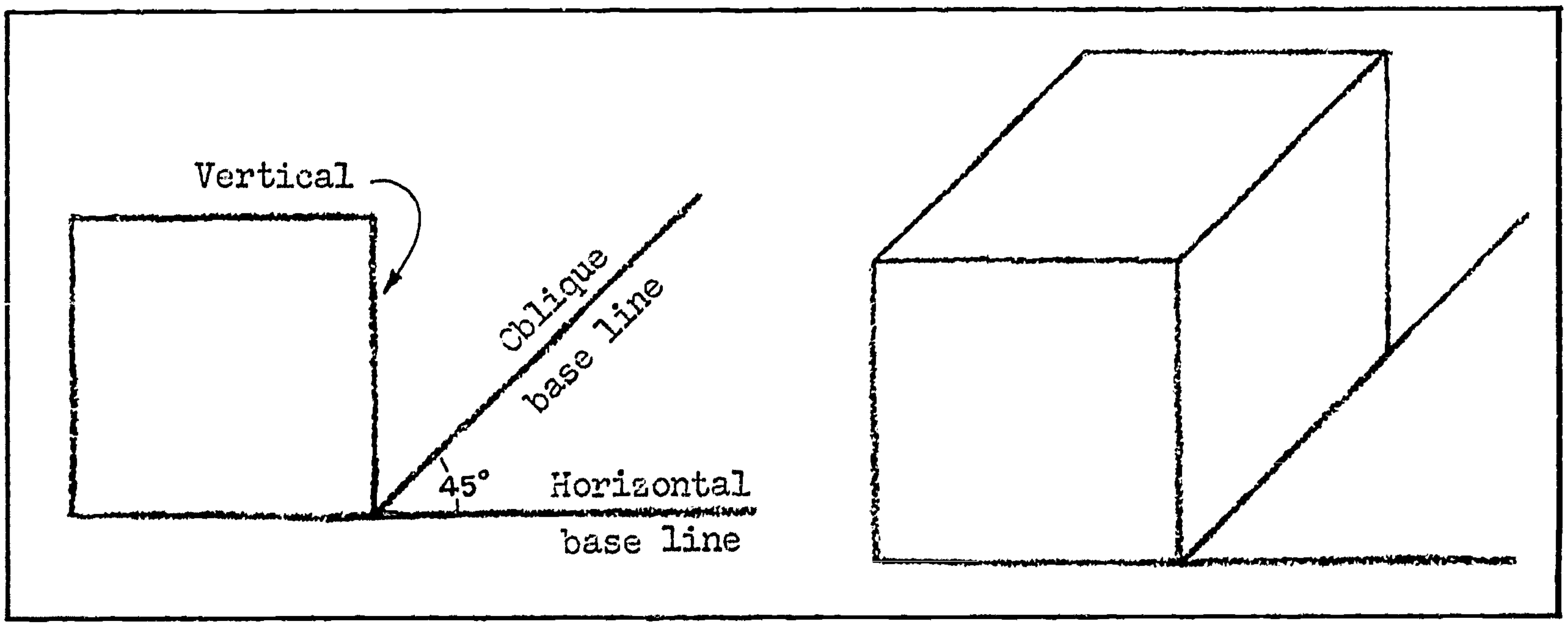


Fig. D-4. Oblique drawing of a cube

Cabinet drawing. To overcome this difficulty, at least in part, a type of drawing called "cabinet" drawing has been adopted by many persons who make working sketches. In cabinet drawing, an oblique drawing is laid out with the receding lines at a 30° or 45° angle, but these lines are foreshortened exactly one-half. The object then looks relatively natural, and dimensions can still be approximated because the object's receding lines are understood to be twice the line length shown. In other variations of oblique drawings, the receding lines are foreshortened by two thirds or three fourths.

Isometric drawing. A dimensionable sketch of a simple object can be made by what is called "isometric" drawing. A drawing made this way is sketched on three base lines--one vertical and two at 30° to the horizontal; these are the "isometric axes." All horizontal lines are drawn parallel; all vertical lines are drawn parallel; and all lines that are parallel on the object are parallel in the drawing. Lengths are marked out to scale. As in oblique drawing, this method results in a slightly distorted view, which would be confusing if the object were very complicated. An isometric drawing of a cube is shown in Fig. D-5.

Perspective drawing. The most frequently used method of pictorial drawing is called "perspective" drawing. An object depicted by this method has a natural appearance, because all lines are drawn in relation to the horizon in the same manner as they would appear to the eye. In this type of drawing, all parallel straight lines seem to converge toward a "vanishing point" at the horizon, which is the eye level of the viewer. The portions of the object nearest the viewer appear largest. Lines and surfaces become smaller and closer together as the distance from the eye increases (Fig. D-6).

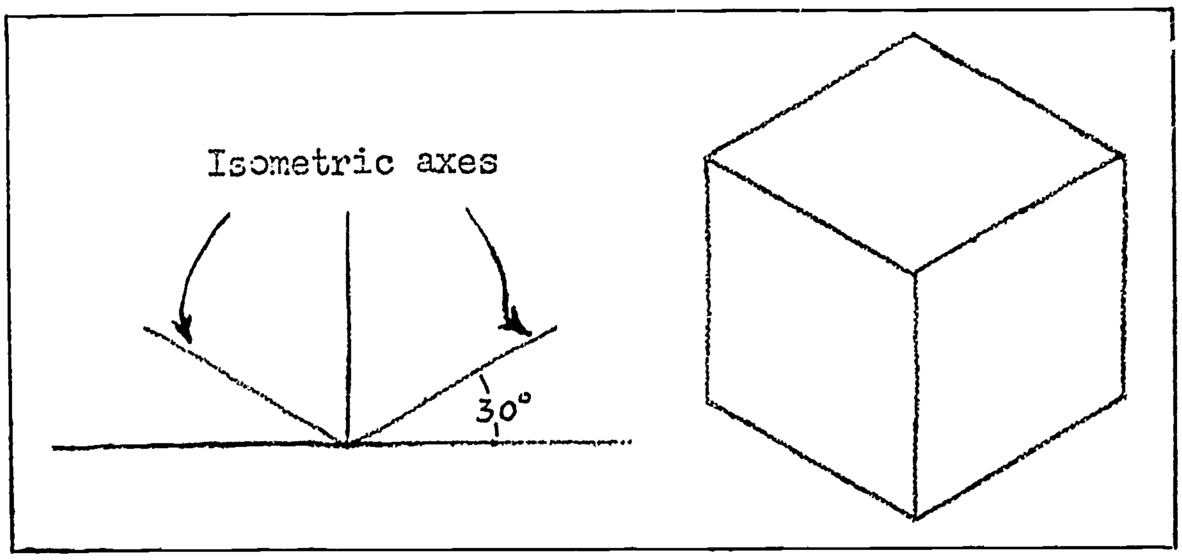


Fig. D-5. Isometric drawing of a cube

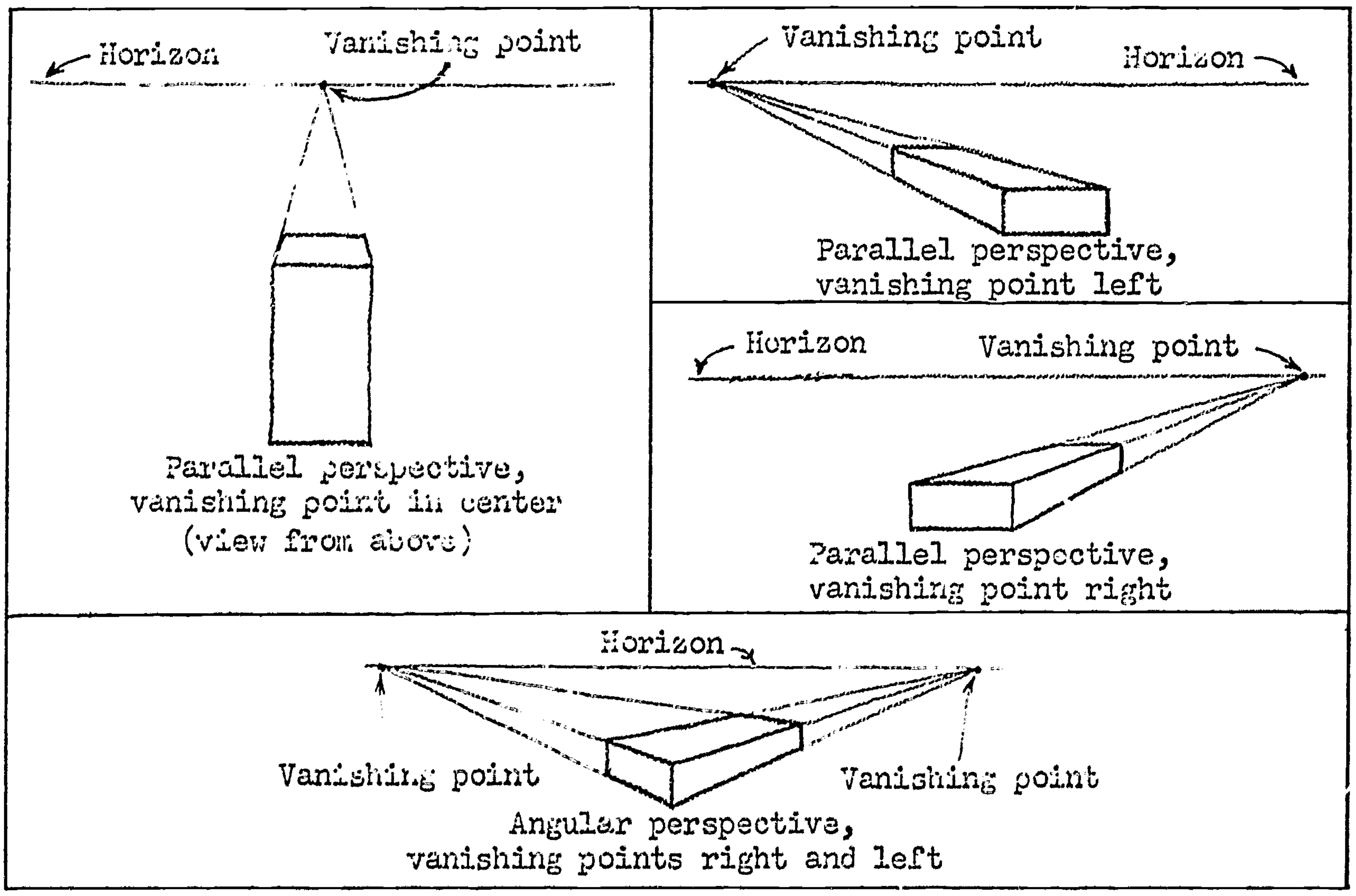


Fig. D-6. Perspective drawings of a brick

There are two types of perspective drawing. In the first, called "parallel" perspective, one face of the object is toward the viewer, and the lines composing the remainder of the faces (except those of the rear face) converge toward one point on the horizon. If the view is from directly in front of and above the object, this point will be in the center of the horizon. If the view is from one side and above the object, the point will be either to the right or to the left of the viewer. The most frequently used type of perspective, however, is called "angular" perspective. In this method, lines on one side converge to the right, and lines on the other converge to the left.

Orthographic projection. Working drawings, which are produced by the drawing method called orthographic projection, do not represent objects as naturally as pictorial drawings. Elevations and floor plans, for instance, show only one view of a building at a time, and each view includes only those portions of the building directly facing the viewer. It would take six such views to show all sides of an object that has length, width, and thickness. In practice, however, usually not more than three views are necessary to convey the desired information. (See Fig. D-7.) Elevation drawings are an exception to this, since four views are required to represent the front, rear, and both sides of a structure.

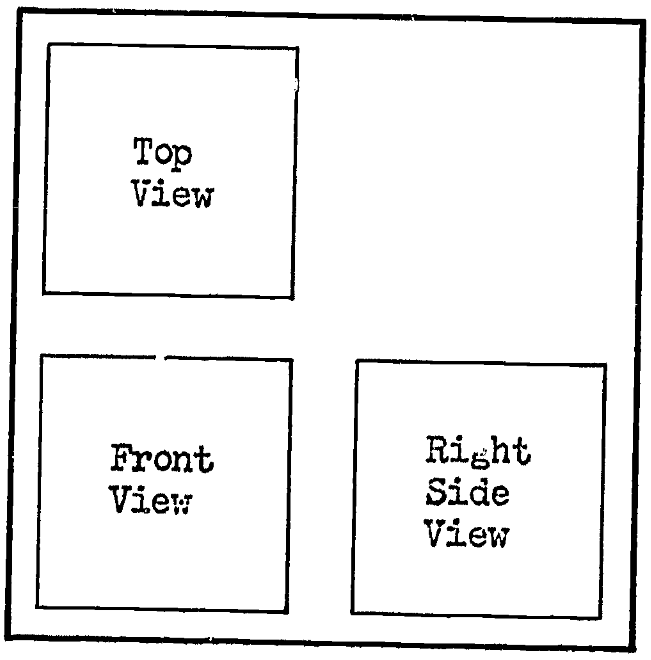


Fig. D-7. Orthographic projection of a cube (note: views must appear in the positions shown)

Floor plans, section drawings, and detail drawings are special cases of orthographic projection. A floor plan represents the view from directly above if the top of the building were cut off at a designated level. A section drawing represents a view from a point directly in front of the cut if the object were cut along the plane indicated by the section line. Detail drawings are usually enlargements of parts of another drawing.

Dimension Lines

Dimension lines in sketches and drawings should be drawn in the direction the arrow is pointing, and the pencil should not be lifted from the paper until the arrowhead is completed. The size of the sketch or drawing and the space allowed determine the size of the arrowheads to be used; in general, the length should be about three times the width. The arrowhead should always be sharp.

Dimension lines should be no less than 1/4 in. away from the drawing and preferably as much as 1/2 in. They are placed between views and outside the drawings whenever possible. Dimensions are placed so that they can be read conveniently.

The preferred method of dimensioning circles is to place the dimensions outside the circle; however, the dimensions may be placed inside. Unless their reference is obvious, the dimensions should be followed by "R" or "D," indicating radius or diameter. (See Fig. D-8.)

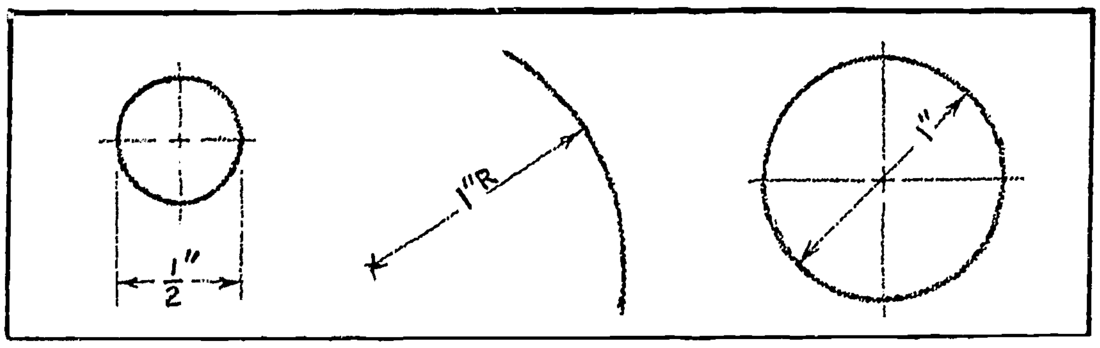


Fig. D-8. Dimensioning circles

Special Kinds of Drawings

Two special kinds of drawings (cutaway and exploded-view) are particularly valuable for the workman. Cutaway drawings show the interior of objects, sometimes to make clear the operation of a mechanism but often simply to show its interior construction, as in the case of a wall or other parts of a building. Exploded-view drawings are used to show how parts are fitted together; they are particularly appropriate for showing how parts of a complex mechanism fit together.

Study Assignment

1. Practice drawing lines and sketching circles, triangles, and rectangles.

2. Practice sketching a number of simple objects (cubes, rectangular boxes, or other objects that may be assigned by your instructor). Draw some of the objects in oblique, some in isometric, some in angular perspective, and some in orthographic projection.

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. In perspective drawings, parallel receding lines appear to converge toward a vanishing point.	1.	T	F
2. A floor plan is a kind of orthographic drawing.	2.	T	F
3. One or more of four basic geometric forms are part of any drawing.	3.	T	F
4. A cabinet drawing is a kind of isometric drawing.	4.	T	F
5. An object appears slightly distorted in an isometric drawing.	5.	T	F
6. A parallel perspective drawing has two vanishing points.	6.	T	F
7. An isometric drawing has four isometric axes.	7.	T	F
8. The first step in sketching a circle is to draw intersecting vertical, horizontal, and oblique lines as guides.	8.	T	F
9. The edges of a cube in an isometric drawing are drawn to scale length.	9.	T	F
10. Dimension lines should be placed within the outline of the object whenever possible.	10.	T	F

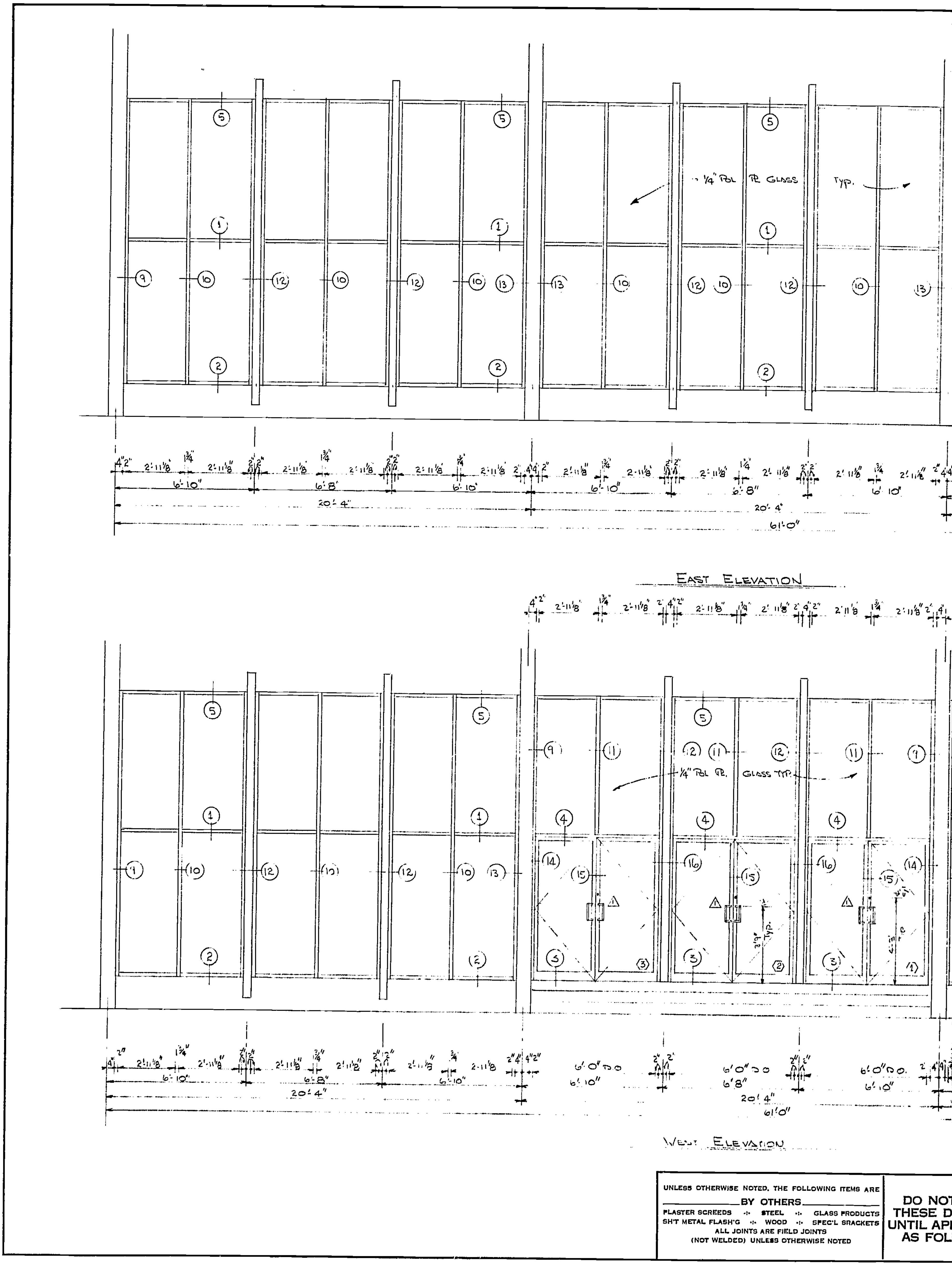
UNIT D--BLUEPRINT READING AND SKETCHING

TOPIC 6--SKETCHING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Sketching develops accuracy of __1__.	1. ________
2. Blocking in the outlines of a sketch requires the use of a fairly __2__ pencil.	2. ________
3. Before the sketching of an object is begun, __3__ should be laid out.	3. ________
4. The distance between the dimension line and the drawing should be at least __4__ inch.	4. ________
5. In sketching, arm movement should be __5__.	5. ________
6. The basic forms used in sketching are __6__, __7__, __8__, and __9__.	6. ________ 7. ________ 8. ________ 9. ________
7. Straight lines in sketching are either horizontal, vertical, or __10__.	10. ________
8. A perspective drawing is a type of __11__ drawing.	11. ________
9. In a cabinet drawing, receding lines are __12__.	12. ________
10. Plans and elevations are __13__ projections.	13. ________


1/4" POL PL GLASS TYP.
EAST ELEVATION
1/4" POL PL GLASS TYP.
WEST ELEVATION
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE D
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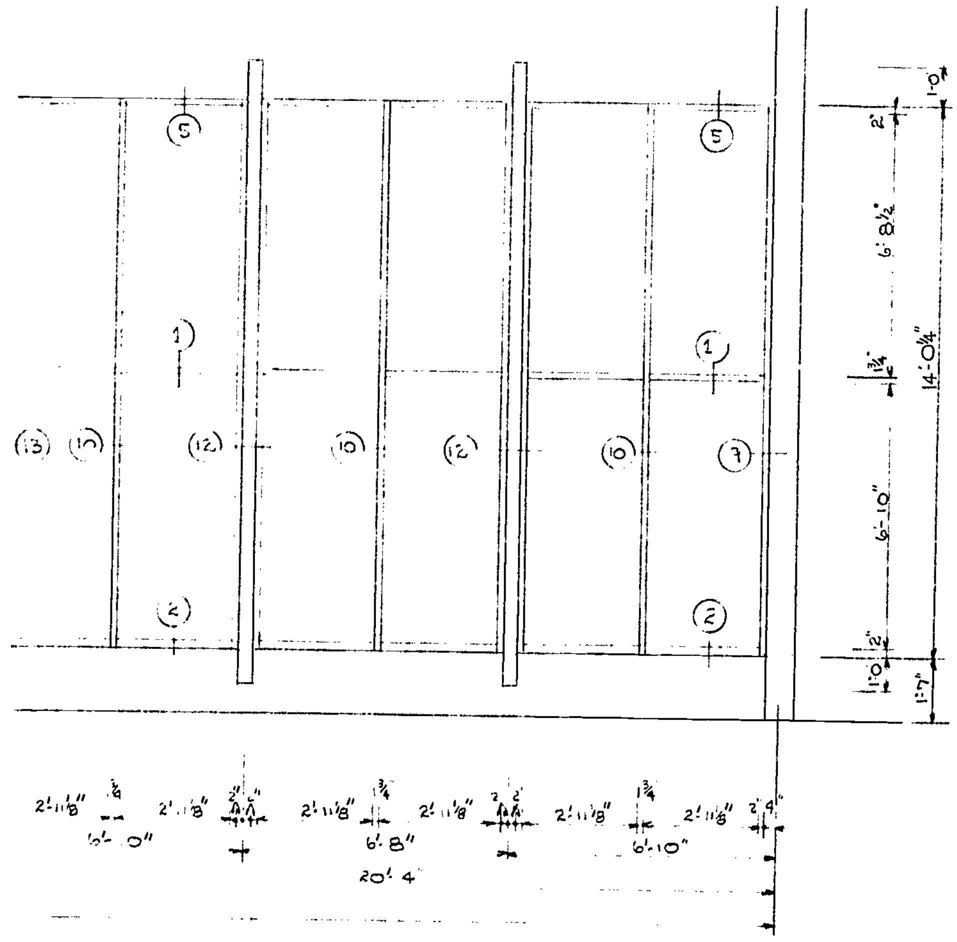
PLAN 1



#1 #2 #3 Pair of Door Center Hung. Single Acting - Swings Out

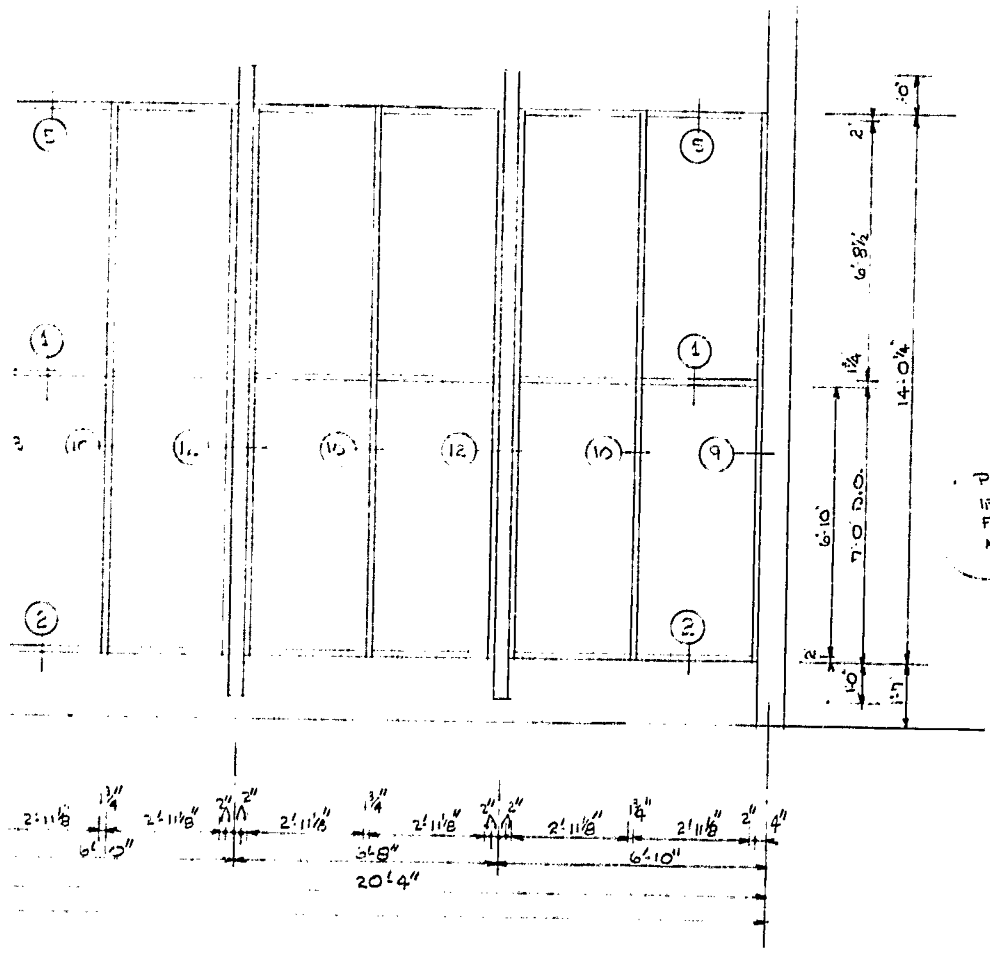
HARDWARE BY KAWNEER

QTY.	NUMBER	DESCRIPTION
6	Kawneer 37-628	C.O.C. CHECKS w/90° H.O.
⚠ 3	500-A	THRESHOLD
		~~" COVER PLATE~~
3	47-252	DEAD LOCK W/ cyl. by others
6	37-227	FLUSH BOLTS
-	-	~~PUSH~~
12	Type "A"	PULL Handles

Note: Do Not Drill Holes For Push Bars. ⚠

Note: No Exposed Nameplates on Doors or Frames ⚠ (and no holes)

Note: Screw Heads @ Anchors To Be Concealed. ⚠



please clarify if Locks & Flush Bolts are Required

No Locks Req'd ⚠

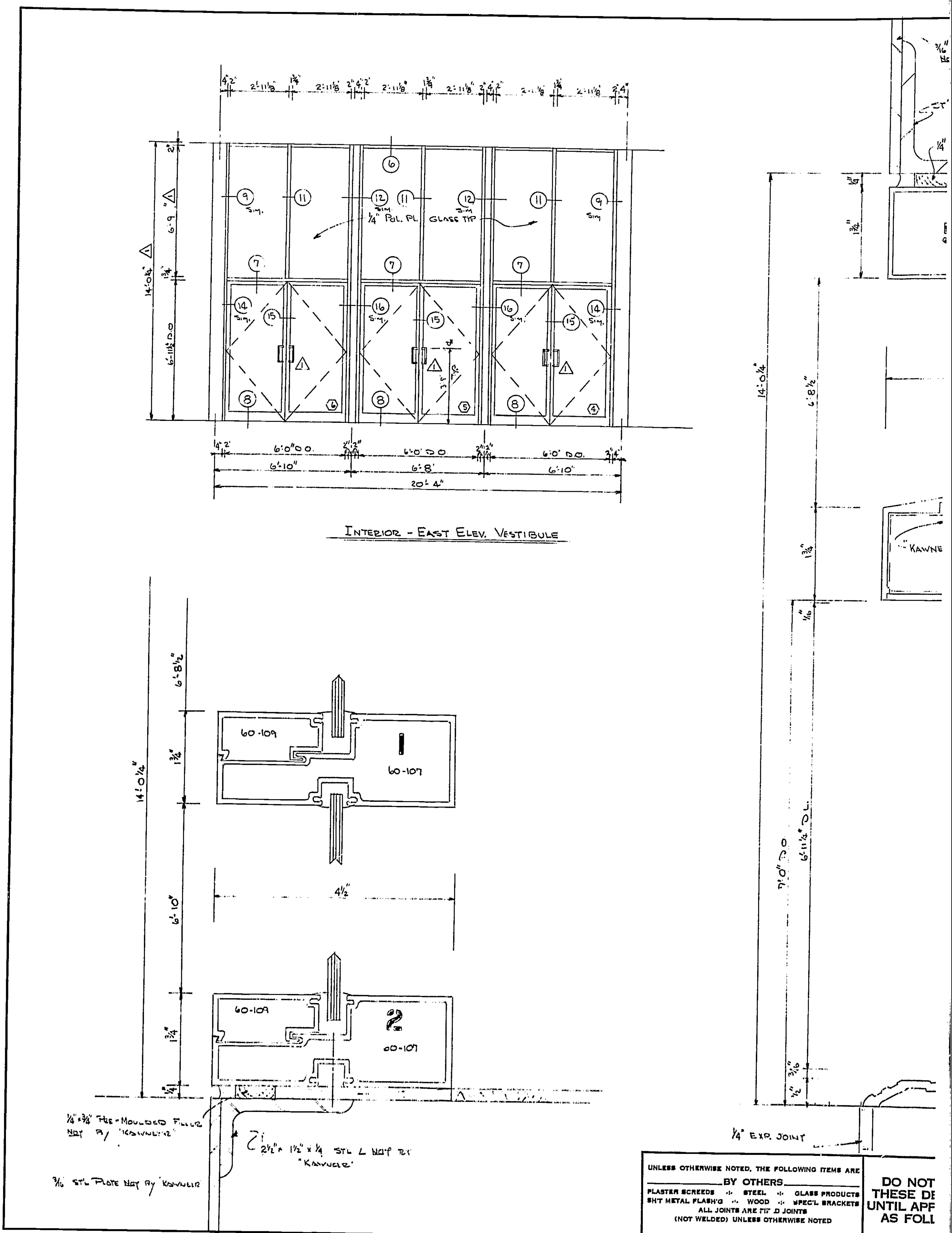
#4 #5 #6 Pair of Doors Center Hung - Single Acting - Swings Out

HARDWARE BY KAWNEER

QTY.	NUMBER	DESCRIPTION
6	Kawneer 37-628	COC CHECKS w/90° H.O.
		~~THRESHOLD~~
		~~" COVER PLATE~~
		DEAD LOCK W/
		FLUSH BOLTS
		~~PUSH~~
12	Type "A"	PULL Handles ⚠

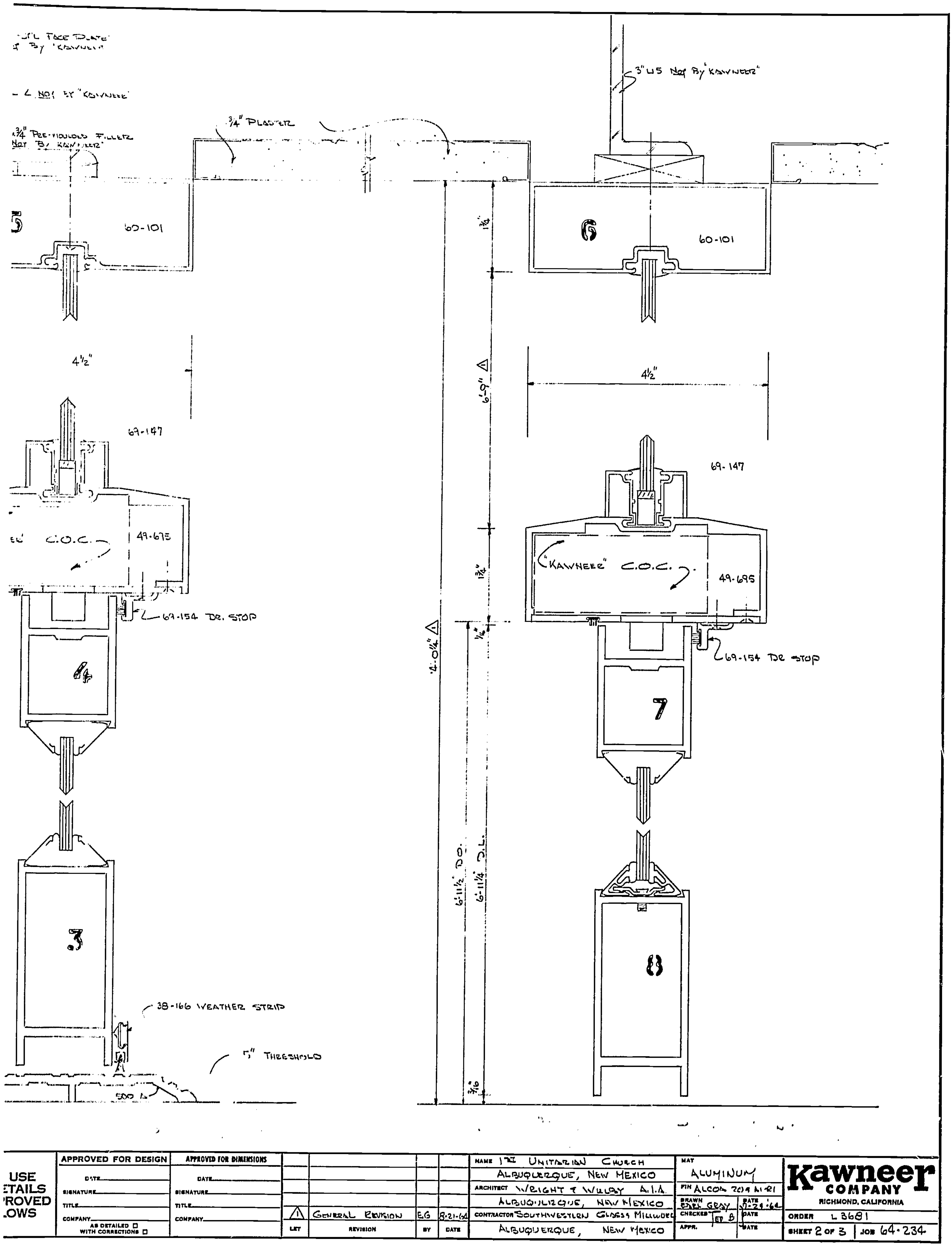
USE TAILS ROVED OWS	APPROVED FOR DESIGN DATE SIGNATURE TITLE COMPANY AS DETAILED ☐ WITH CORRECTIONS ☐	APPROVED FOR DIMENSIONS DATE SIGNATURE TITLE COMPANY	⚠ General Revision E.G. 8-21-64 (LET / REVISION / BY / DATE)
NAME 1st Unitarian Church Albuquerque, New Mexico	ARCHITECT Wright & Welby A.I.A. Albuquerque, New Mexico	CONTRACTOR Southwestern Glass & Millwork Albuquerque, New Mexico	
MAT Aluminum	FIN Alcoa 204 A1-R1	DRAWN Earl Gray DATE 7-24-64	CHECKED E.D.B. DATE / APPR. DATE
Kawneer COMPANY RICHMOND, CALIFORNIA	ORDER L 3681	SHEET 1 OF 3	JOB 64.234

PLAN 1

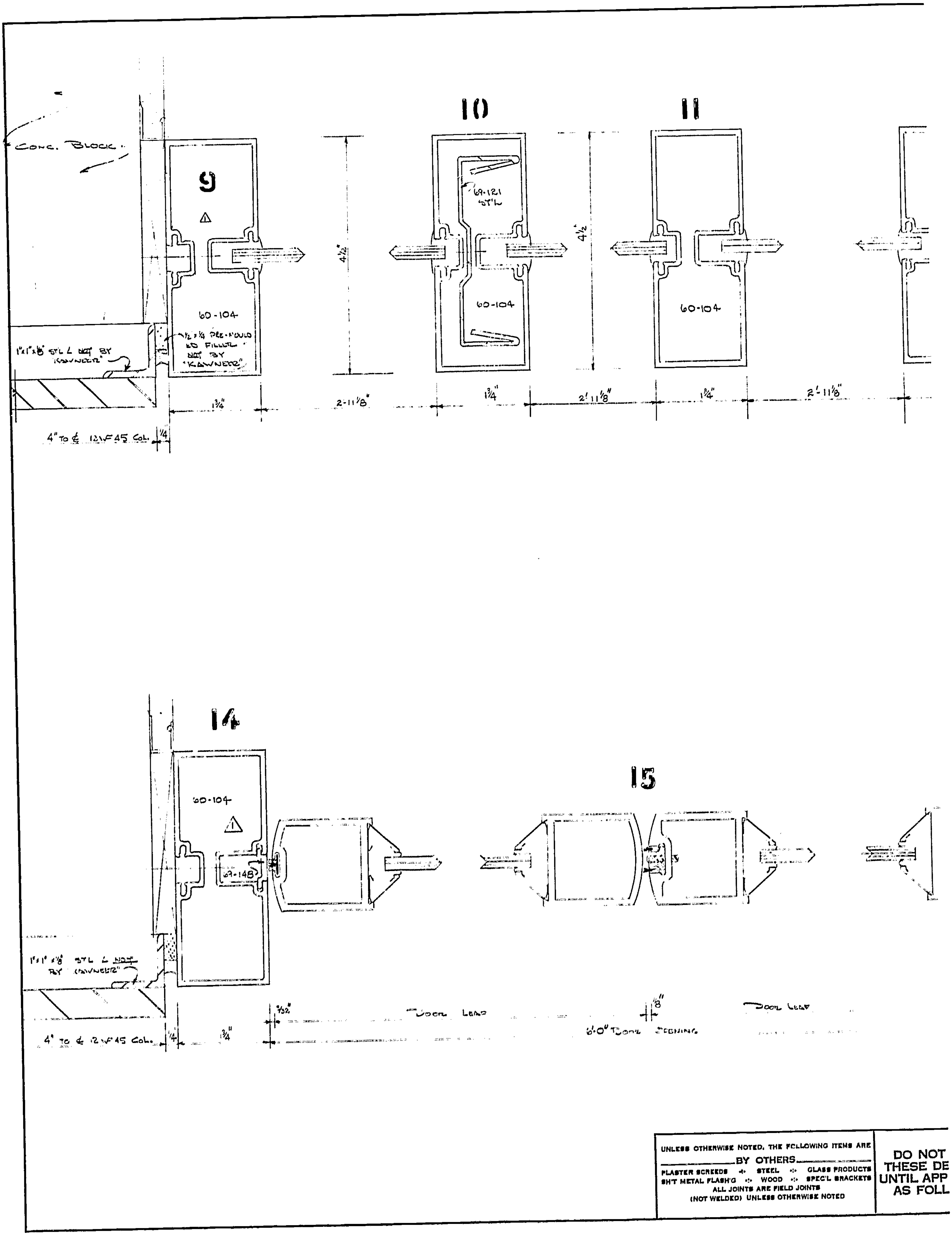


INTERIOR - EAST ELEV. VESTIBULE
1/4" POL. PL. GLASS TYP
6'-10"
6'-8'
6'-10"
20'-4"
14'-0 1/4"
60-109
60-107
4 1/2"
1/4" x 3/4" PRE-MOULDED FILLER NOT BY "KAWNEER"
2 1/2" x 1 1/2" x 1/4 STL L NOT BY "KAWNEER"
3/16 STL PLATE NOT BY KAWNEER
1/4" EXP. JOINT
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SHT METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIT'D JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DE
UNTIL APP
AS FOLL

PLAN 2

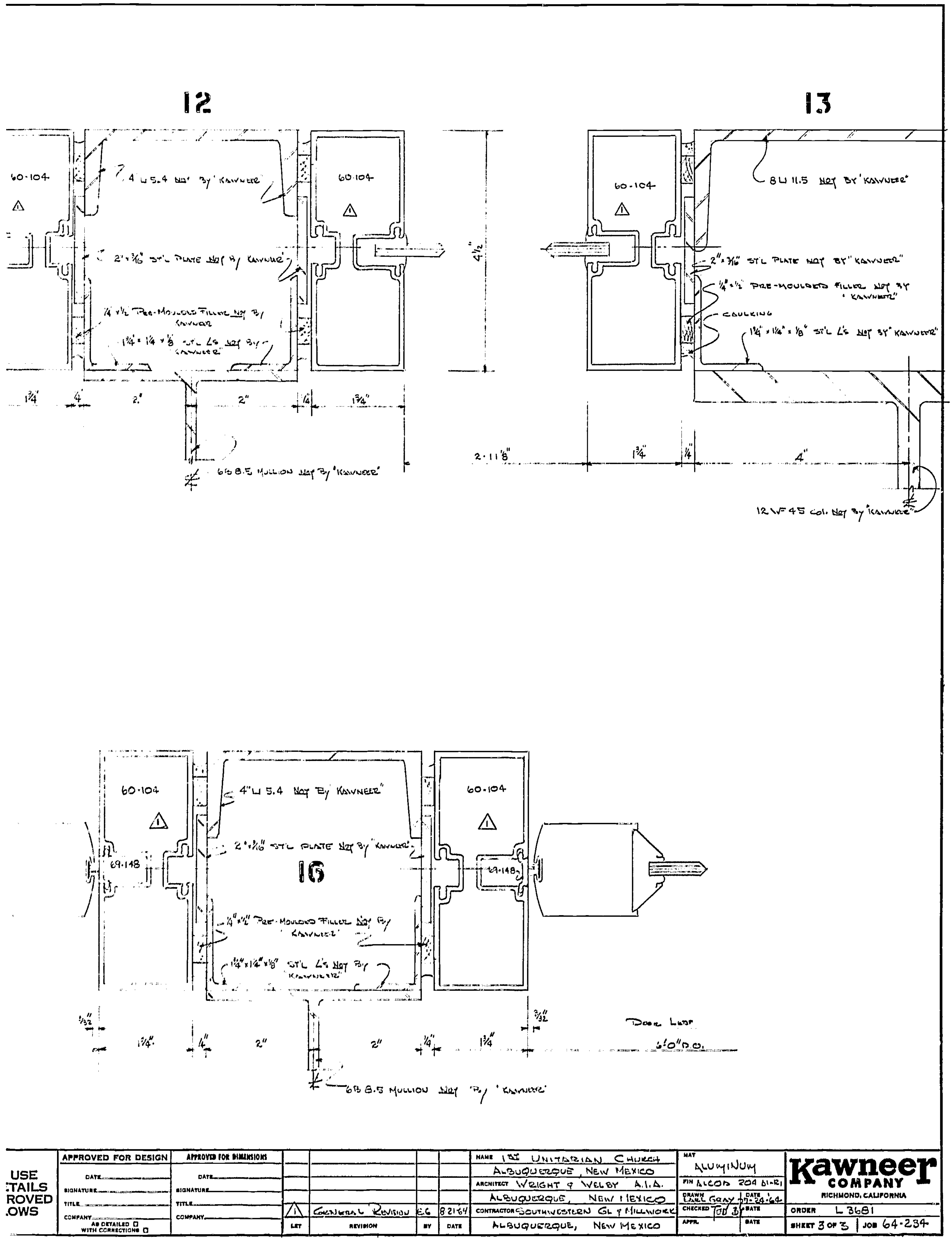

3/4" PLASTER
3" US Not By "Kawneer"
60-101
60-101
4 1/2"
4 1/2"
6'-9"
4'-0 1/4"
69-147
69-147
C.O.C.
49-695
"KAWNEER" C.O.C.
49-695
69-154 DR. STOP
69-154 DR STOP
6'-11 1/2" D.O.
6'-11 1/4" D.L.
38-166 WEATHER STRIP
5" THRESHOLD
APPROVED FOR DESIGN
APPROVED FOR DIMENSIONS
GENERAL REVISION
NAME 1ST UNITARIAN CHURCH
ALBUQUERQUE, NEW MEXICO
ARCHITECT WRIGHT & WILBY A.I.A.
ALBUQUERQUE, NEW MEXICO
CONTRACTOR SOUTHWESTERN GLASS & MILLWORK
ALBUQUERQUE, NEW MEXICO
MAT ALUMINUM
Kawneer COMPANY
RICHMOND, CALIFORNIA
ORDER L 3681
SHEET 2 OF 3
JOB 64-234

PLAN 2

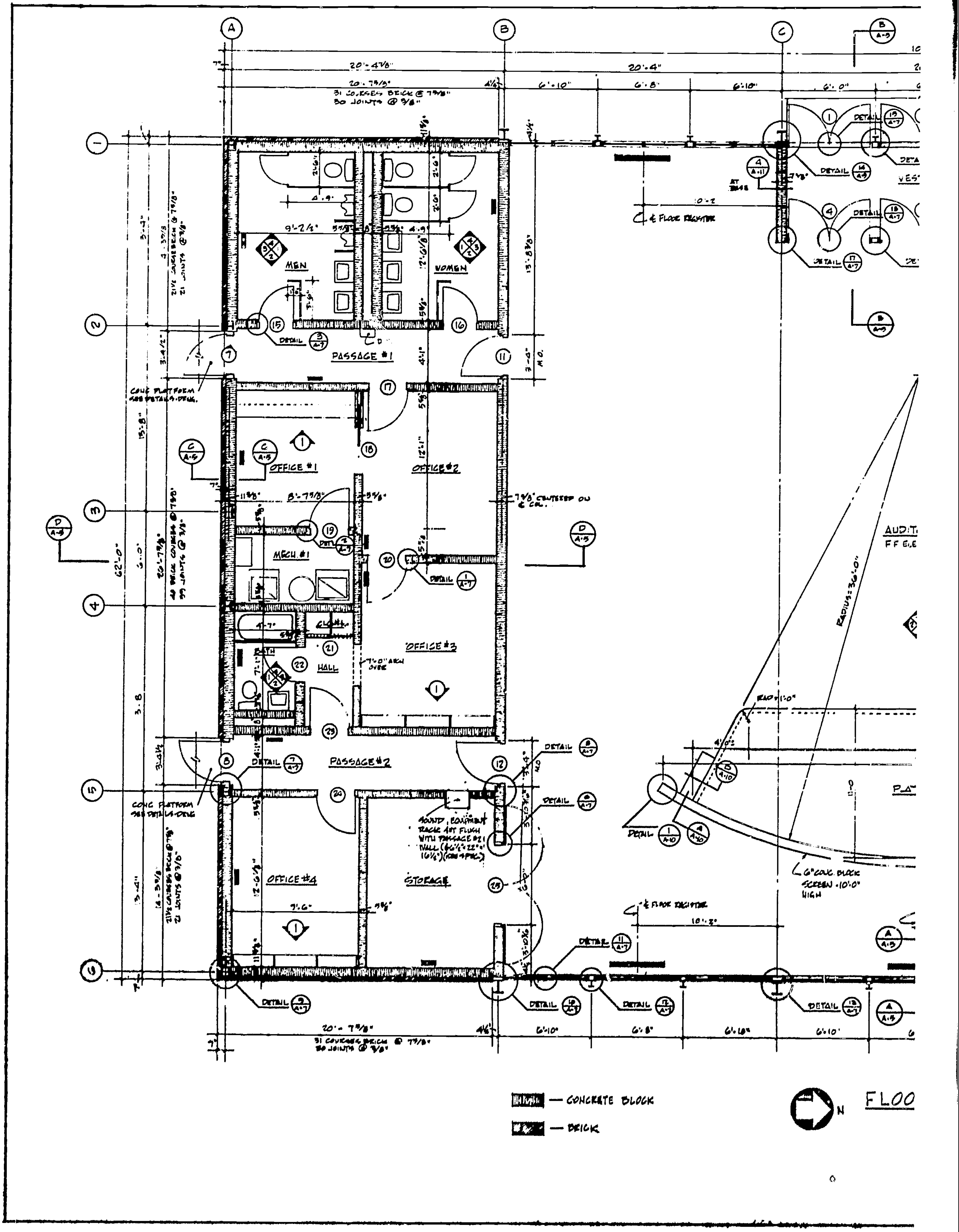


CONC. BLOCK
9
60-104
½ x ⅛ PRE-MOULDED FILLER NOT BY "KAWNEER"
1"x1"x⅛" STL L NOT BY KAWNEER"
1¾"
4" TO ℄ 12 WF 45 COL.
¼
10
69-121 ST'L
60-104
4½"
2-11⅛"
11
60-104
2'-11⅛"
14
60-104
69-148
15
DOOR LEAF
6'-0" DOOR OPENING
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS (NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT THESE DE UNTIL APP AS FOLL

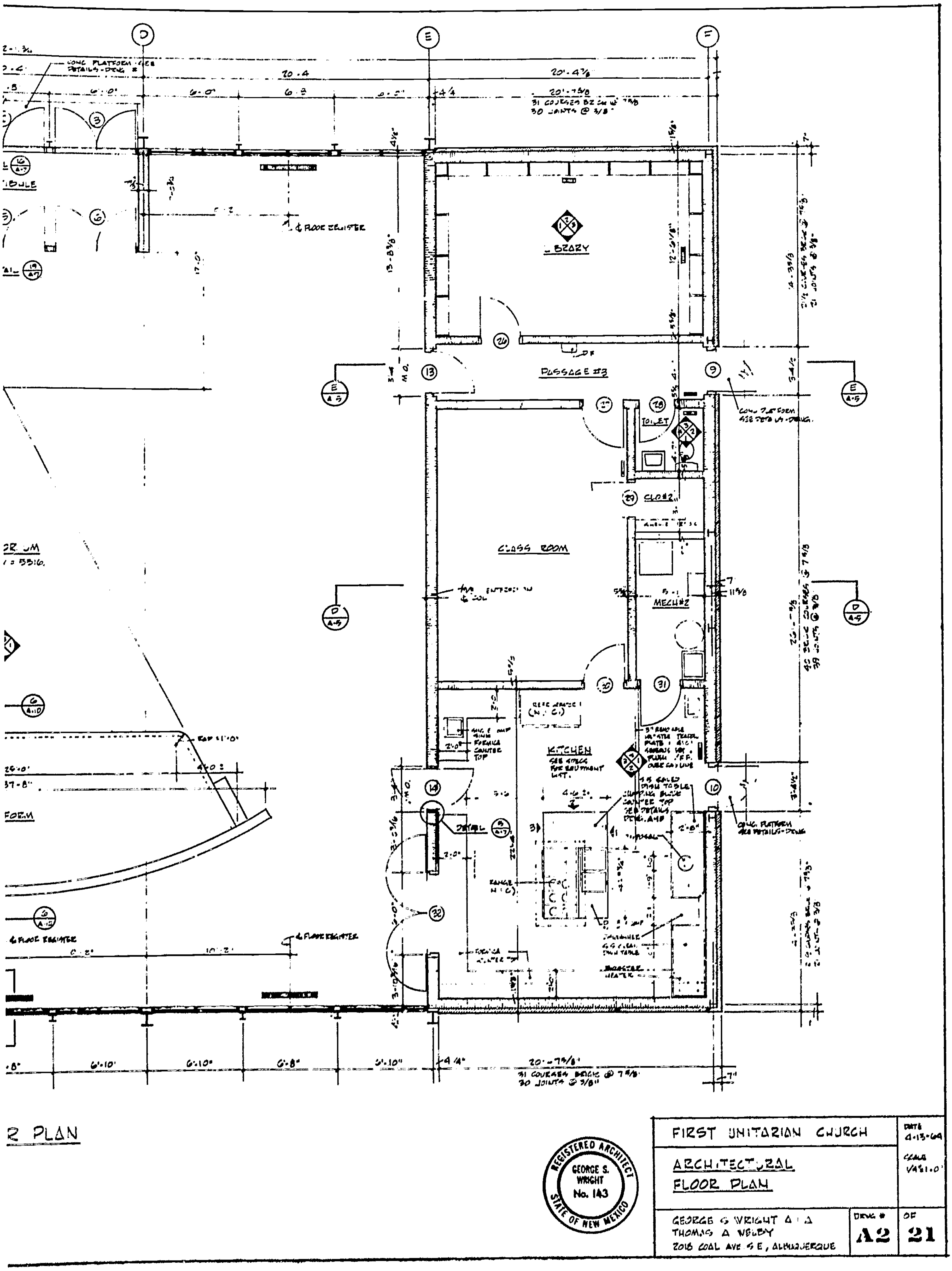
PLAN 3


12
13
60-104
4" ⊔ 5.4 Not By 'Kawneer'
2" x 3/16" St'l Plate Not By Kawneer
1/4" x 1/2" Pre-Moulded Filler Not By Kawneer
1 3/4" x 1 1/4" x 1/8" St'l L's Not By Kawneer
6B 8.5 Mullion Not By 'Kawneer'
4 1/2"
8 ⊔ 11.5 Not By 'Kawneer'
Caulking
12 WF 45 Col. Not By 'Kawneer'
2-11 1/8"
16
69-148
Door Leaf
6'0" D.O.
APPROVED FOR DESIGN
APPROVED FOR DIMENSIONS
General Revision E.G. 8-21-64
1st Unitarian Church
Albuquerque, New Mexico
Architect Wright & Welby A.I.A.
Albuquerque, New Mexico
Contractor Southwestern Gl & Millwork
Albuquerque, New Mexico
Aluminum
Alcoa 204 A1-R1
Order L 3681
Sheet 3 of 3
Job 64-234
Kawneer Company
Richmond, California

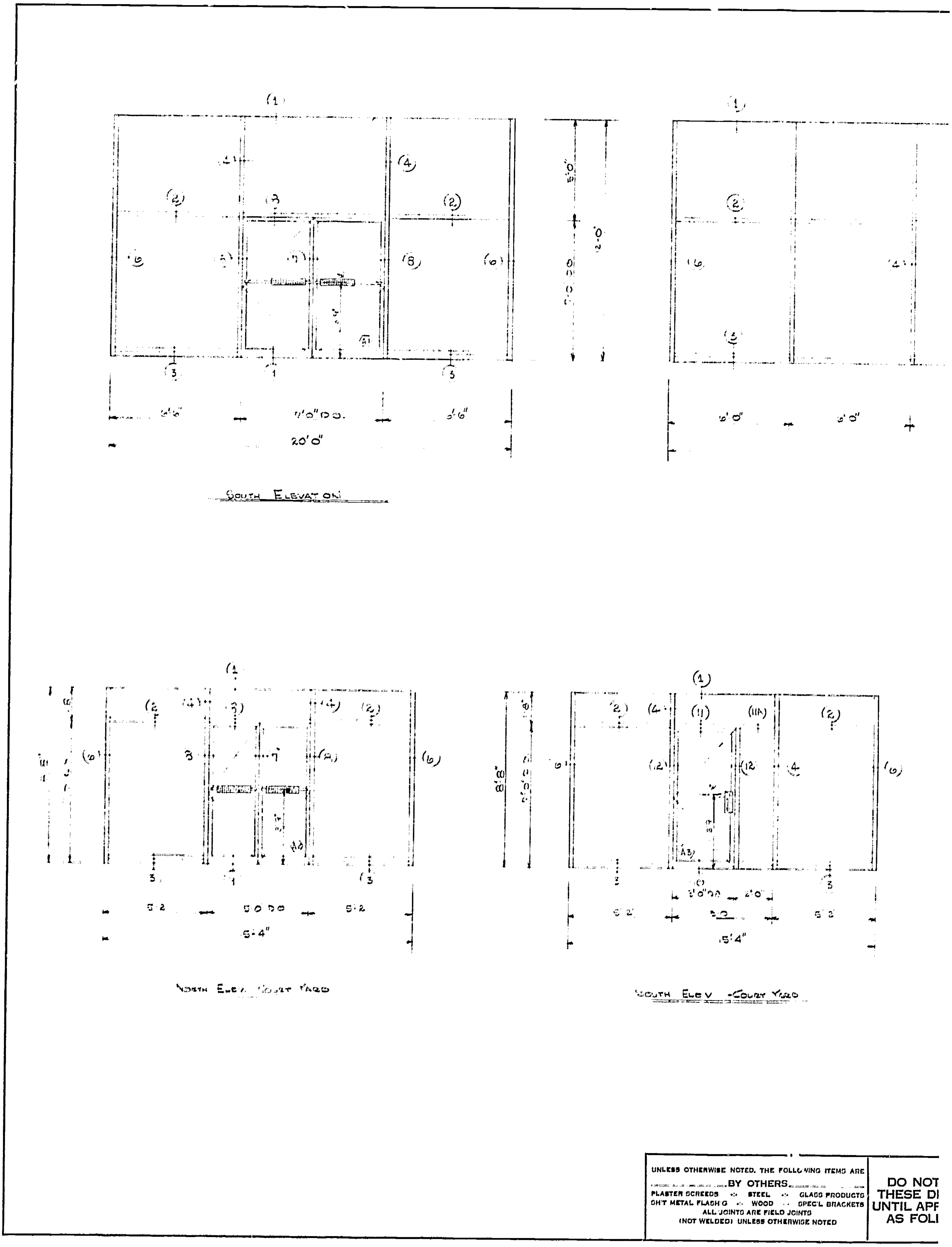
PLAN 3


MEN
WOMEN
PASSAGE #1
OFFICE #1
OFFICE #2
MECH. #1
OFFICE #3
BATH
HALL
PASSAGE #2
OFFICE #4
STORAGE
— CONCRETE BLOCK
— BRICK
FLOO

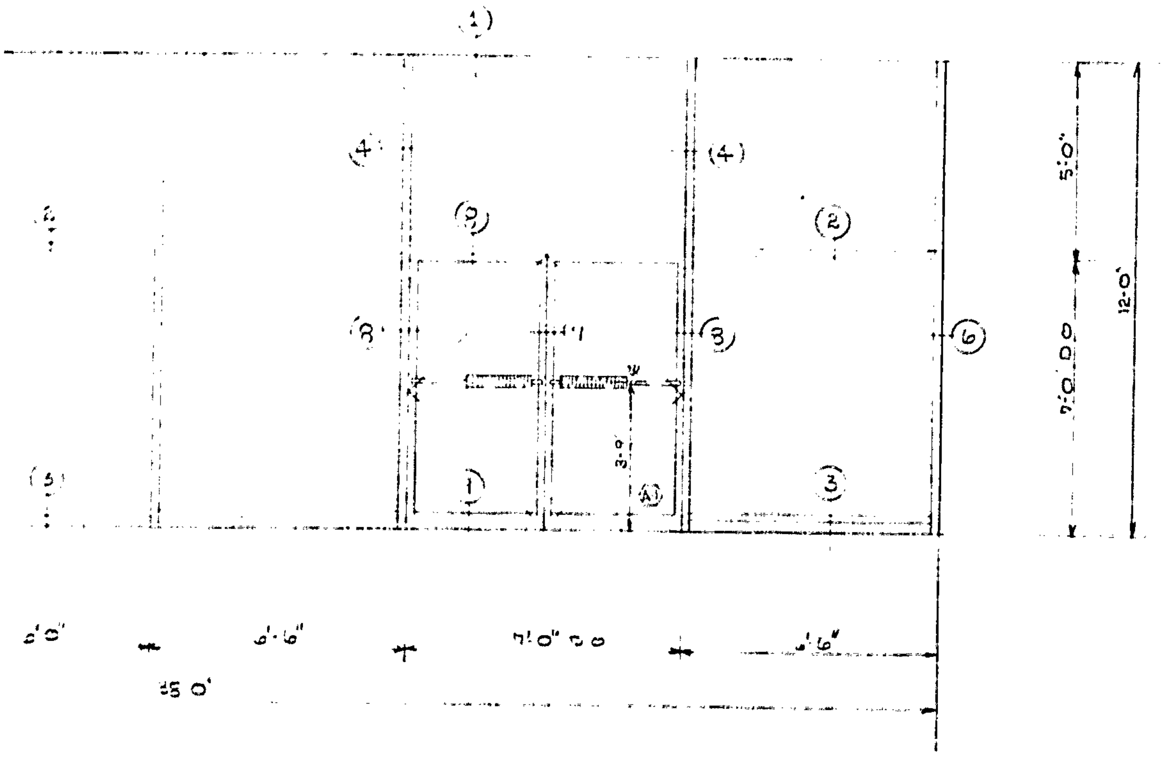
PLAN 4


FIRST UNITARIAN CHURCH
ARCHITECTURAL FLOOR PLAN
GEORGE S. WRIGHT A I A
THOMAS A WELBY
2018 COAL AVE S E, ALBUQUERQUE
DATE 4-13-64
A2
OF 21
REGISTERED ARCHITECT GEORGE S. WRIGHT No. 143 STATE OF NEW MEXICO
LIBRARY
PASSAGE #3
CLASS ROOM
TOILET
CLO #2
MECH #2
KITCHEN
R PLAN

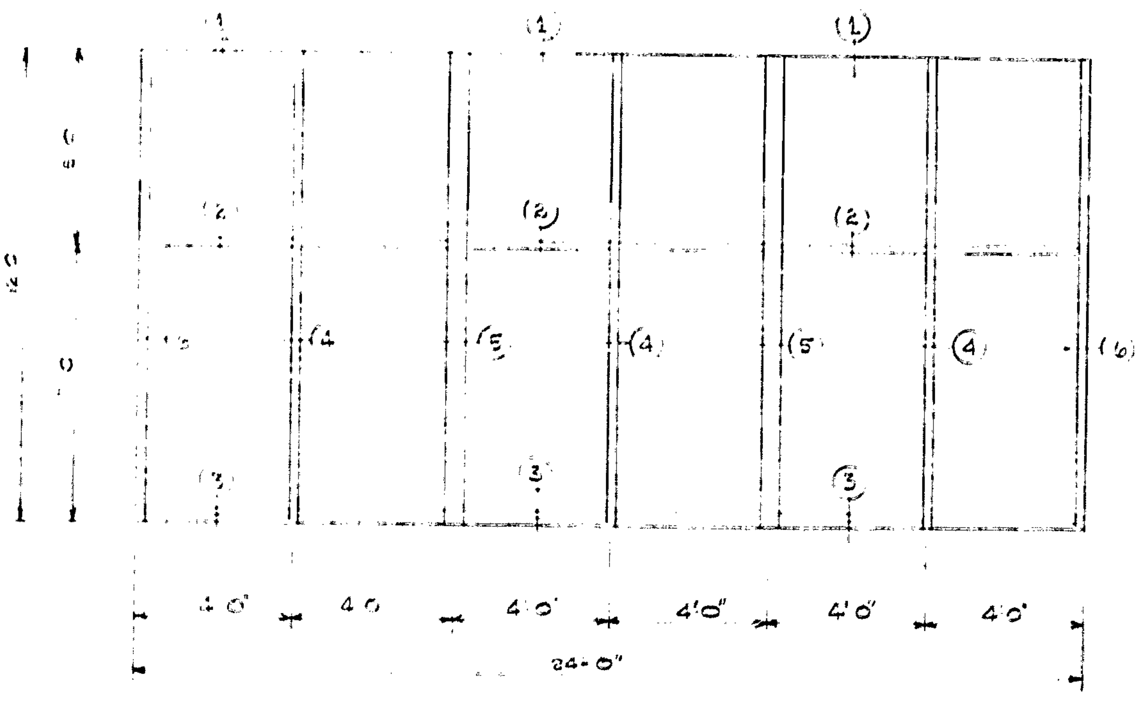
PLAN 4


SOUTH ELEVATION
20'0"
NORTH ELEV. COURT YARD
SOUTH ELEV. - COURT YARD
15'4"
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DI
UNTIL APP
AS FOLL

PLAN 5



North Elevation



West Elev.

2 Pair of Doors (1) Center Hung - Double Acting

HARDWARE BY KAWNEER

QTY.	NUMBER	DESCRIPTION
4	D.O.M. 402	~~FLOOR~~ CHECKS w/ 90° H.O.
2	69-121	THRESHOLD
—	—	~~COVER PLATE~~
2	47.252	DEAD LOCK w/ cyl. by others
4	37.227	FLUSH BOLTS
8	B-1	PUSH Plates
—	—	~~PULL~~

Pair of Doors (1) Center Hung - Double Acting

HARDWARE BY KAWNEER

QTY.	NUMBER	DESCRIPTION
2	D.O.M. 302	~~FLOOR~~ CHECKS w/90° H.O.
1	69-141	THRESHOLD
—	—	~~COVER PLATE~~
1	47.252	DEAD LOCK w/ cyl. by others
2	37.227	FLUSH BOLTS
4	B-1	PUSH Plates
—	—	~~PULL~~

Single Door (3) Offset - Single Acting - Swings Out

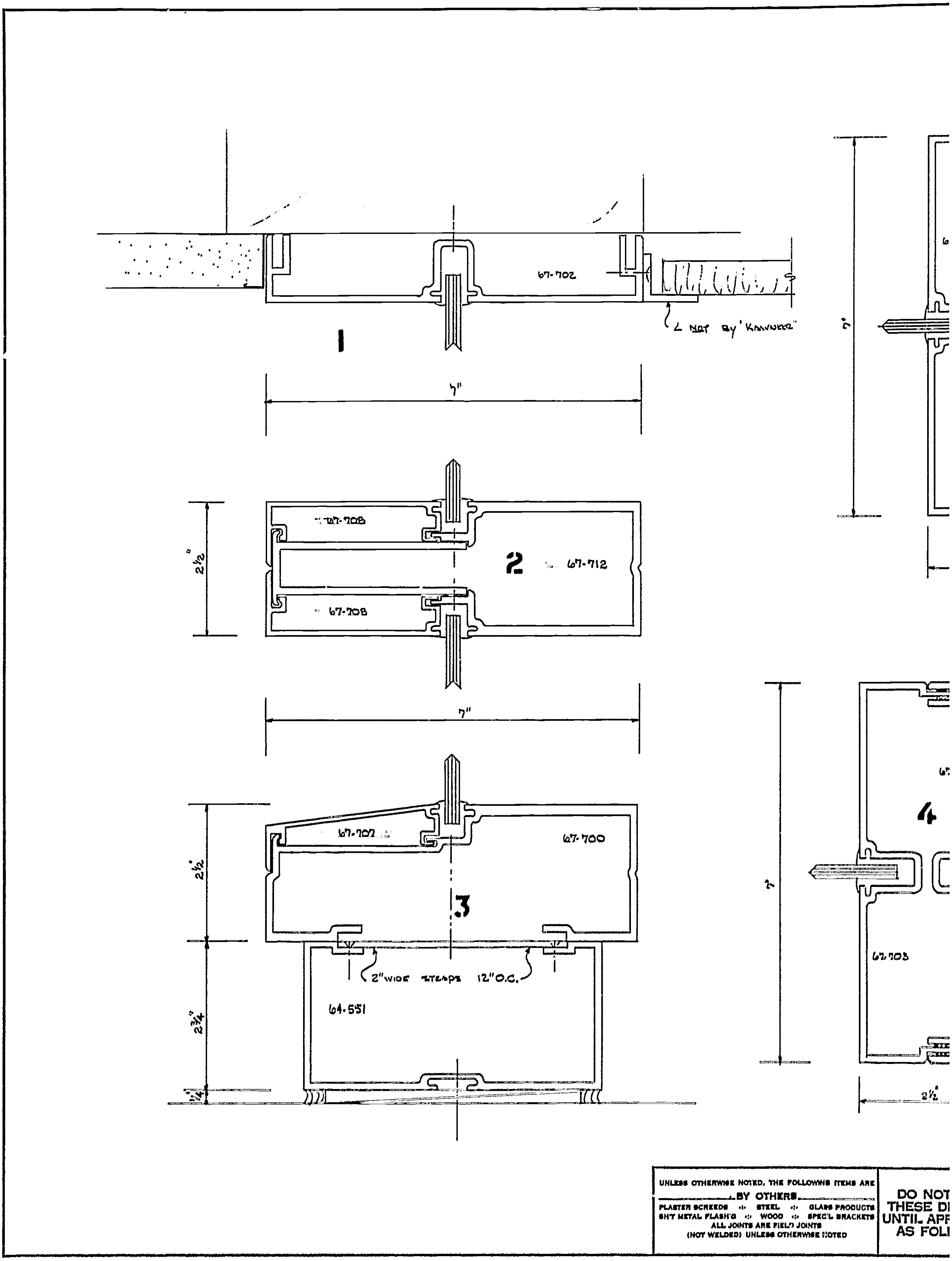
HARDWARE BY KAWNEER

QTY.	NUMBER	DESCRIPTION
1	D.O.M. 252	~~FLOOR~~ CHECKS w/90° H.O
1	69.140	THRESHOLD
—	—	~~COVER PLATE~~
		DEAD LOCK w/
—	—	~~FLUSH BOLTS~~
1	B-1	PUSH Plate
1	B-1	PULL Handle

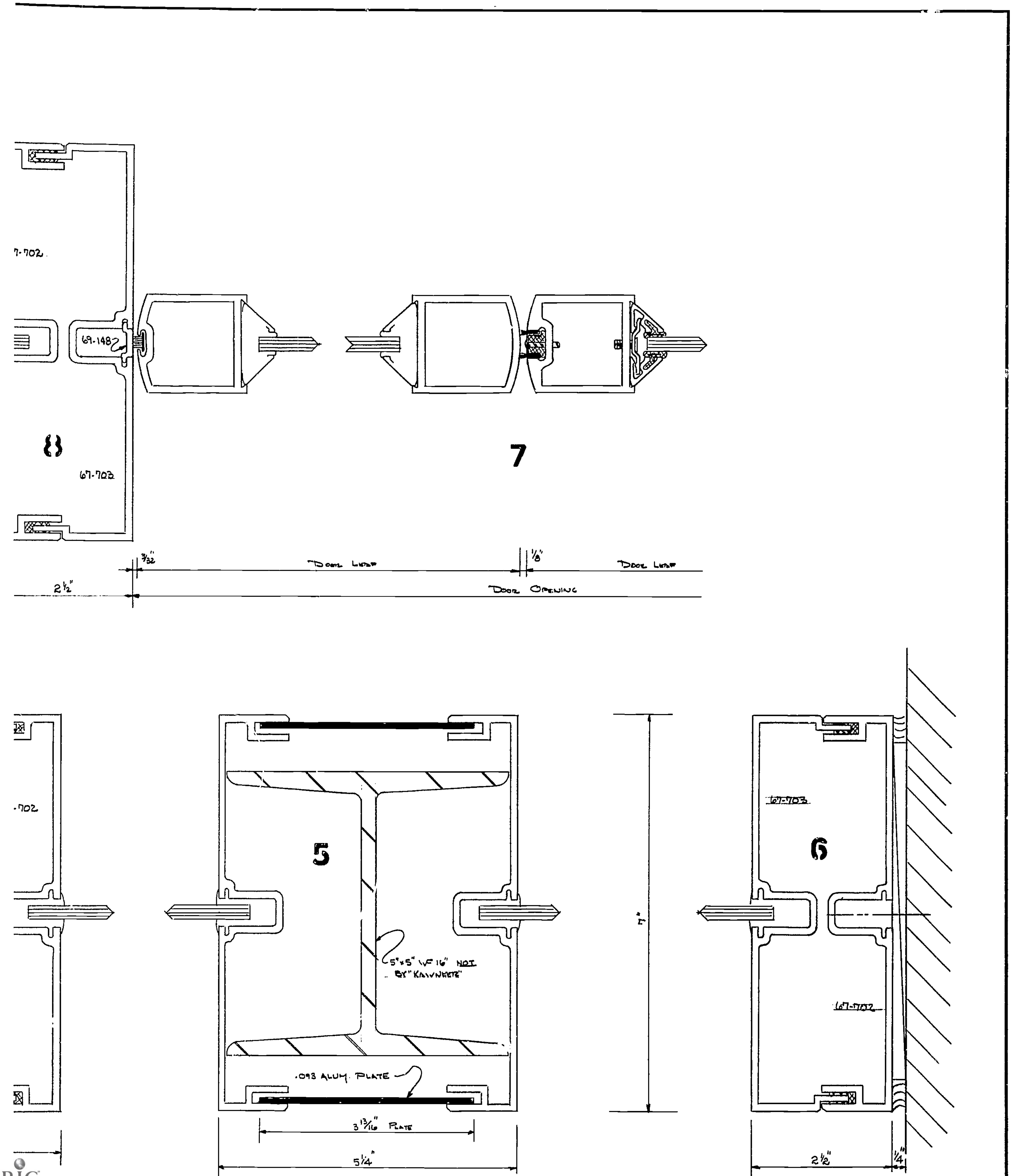
USE
TAILS
ROVED
OWS

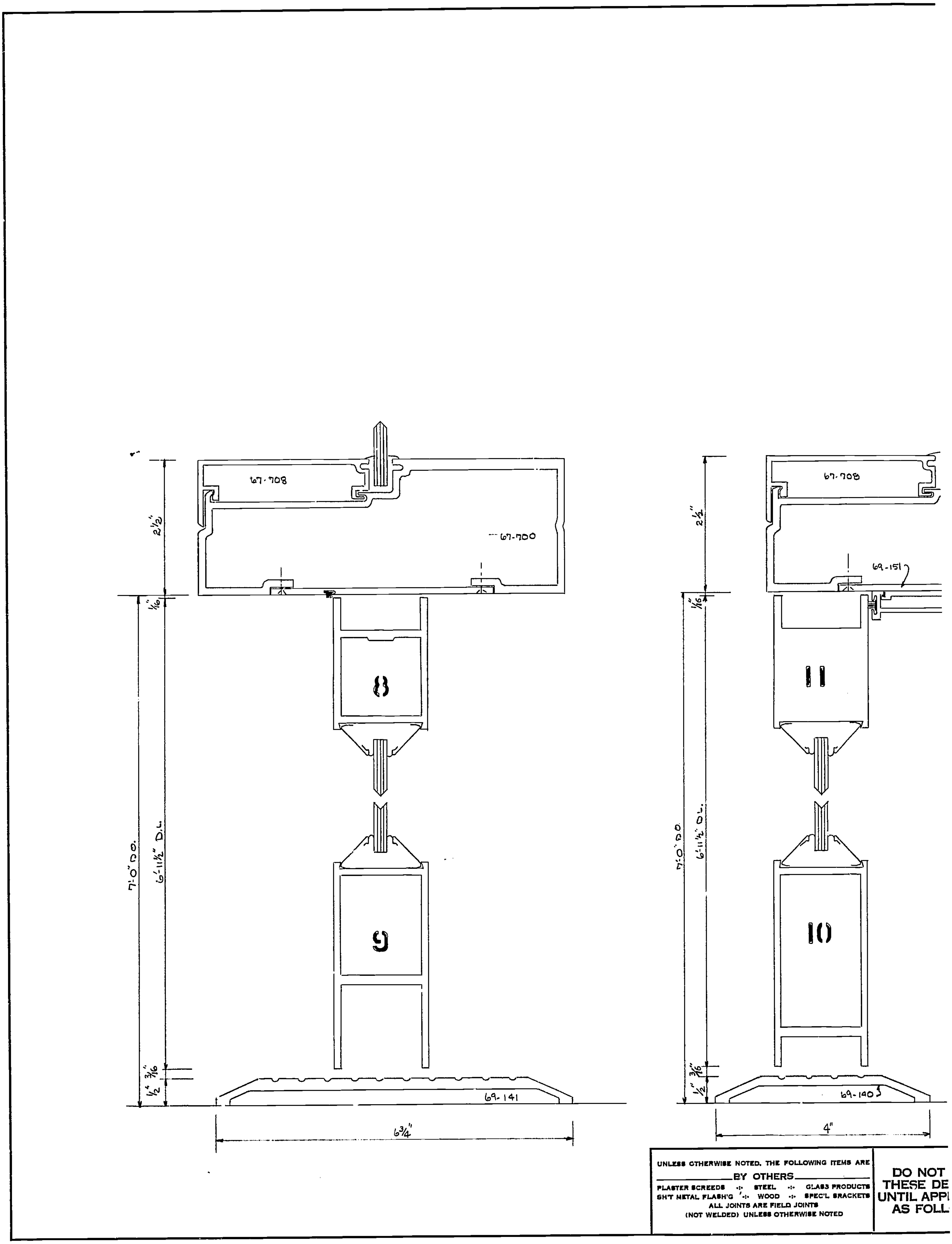
APPROVED FOR DESIGN	APPROVED FOR DIMENSIONS	LET	REVISION	BY	DATE		MAT	
DATE	DATE					NAME Bakersfield National Bank, Bakersfield, Calif	Aluminum	**Kawneer COMPANY** RICHMOND, CALIFORNIA
SIGNATURE	SIGNATURE					ARCHITECT Gogg & Choy, Bakersfield Calif	FIN Permanodic #28	
TITLE	TITLE						DRAWN · DATE 9-8-64	
COMPANY · AS DETAILED · WITH CORRECTIONS	COMPANY					CONTRACTOR Valley Glass Co, Bakersfield Calif	CHECKED · DATE	ORDER L4106
							APPR. · DATE	SHEET 1 OF 3 · JOB 64-278

PLAN 5

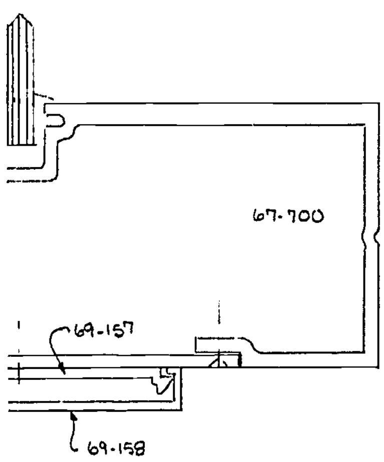

67-702
1
7"
67-708
2
67-712
67-708
2½"
7"
67-702
67-700
3
2½"
2"WIDE STRAPS 12"O.C.
64-551
2¾"
4
67-703
2½"
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SHT METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DI
UNTIL APP
AS FOLI

PLAN 6

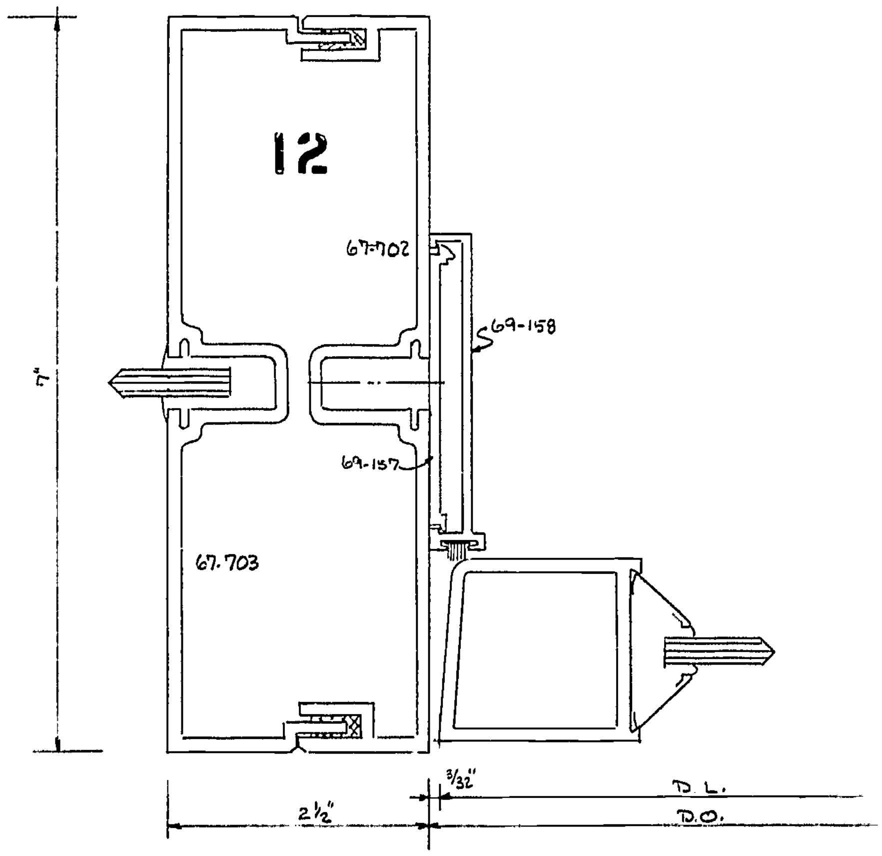

7-702
69-1482
8
67-703
7
3/32"
Door Leaf
1/8"
Door Leaf
2½"
Door Opening
-702
5
5"x5" WF 16" NOT
BY "KAWNEER"
.093 ALUM. PLATE
3 13/16" Plate
5¼"
7"
67-703
6
67-702
2½"
¼"


67-708
67-700
2½"
1/16"
7'-0" D.O.
6'-11½" D.L.
8
9
3/16
½"
69-141
6¾"
69-151
11
10
69-140
4"
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DE
UNTIL APP
AS FOLL

PLAN 7



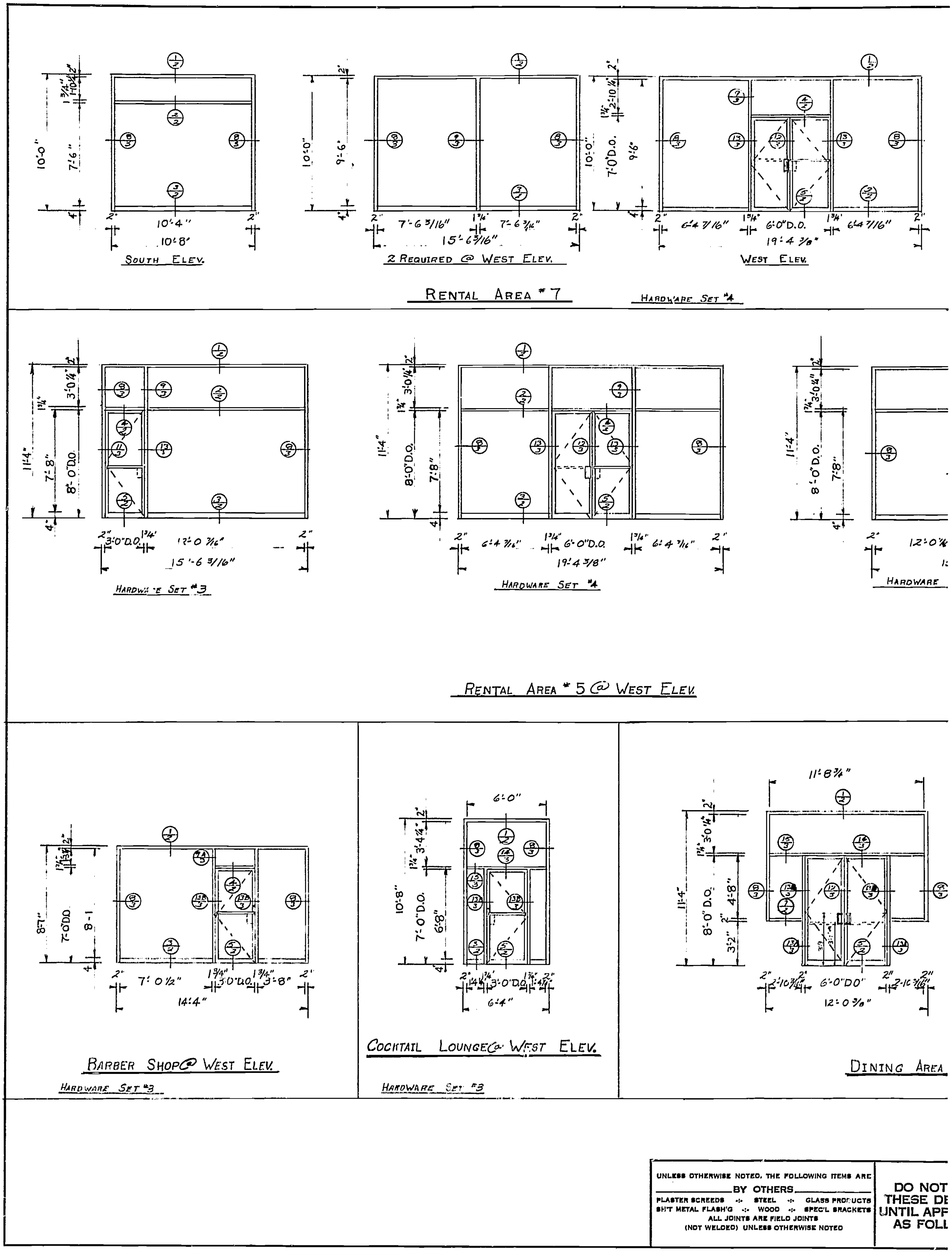
11A OMIT 69-151
ADD 69-152 @
SIDELIGHT



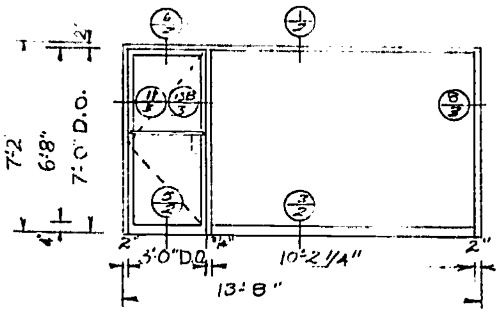
USE TAILS ROVED OWS	APPROVED FOR DESIGN DATE SIGNATURE TITLE COMPANY AS DETAILED ☐ WITH CORRECTIONS ☐	APPROVED FOR DIMENSIONS DATE SIGNATURE TITLE COMPANY	LET / REVISION / BY / DATE	NAME BAKERSFIELD NATIONAL BANK BAKERSFIELD, CALIF. ARCHITECT GOSS & CHOY BAKERSFIELD, CALIF. CONTRACTOR VALLEY GLASS CO. BAKERSFIELD, CALIF.

MAT ALUMINUM FIN PERMANODIC #28 DRAWN Earl Gray DATE 9-18-'64 CHECKED TED B. DATE APPR. DATE	**Kawneer COMPANY** RICHMOND, CALIFORNIA ORDER L4406 SHEET 3 OF 3 JOB 64-278	

PLAN 7

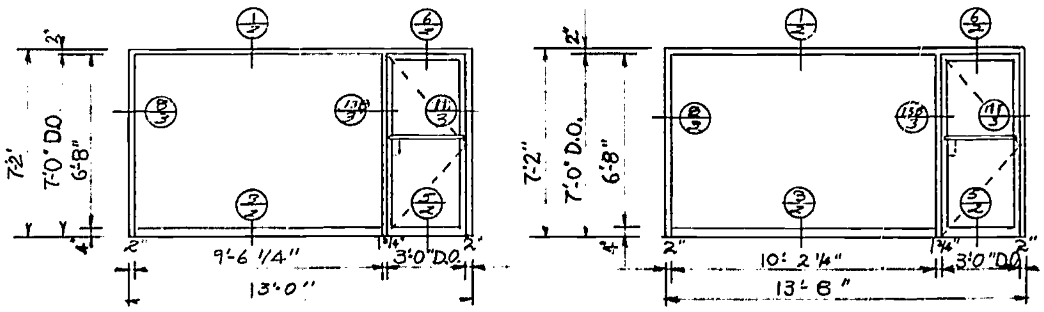

South Elev.
2 Required @ West Elev.
West Elev.
Rental Area # 7
Hardware Set #4
Hardware Set #3
Hardware Set #4
Hardware
Rental Area # 5 @ West Elev.
Barber Shop @ West Elev.
Hardware Set #3
Cocktail Lounge @ West Elev.
Hardware Set #3
Dining Area
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS - STEEL - GLASS PRODUCTS
SH'T METAL FLASH'G - WOOD - SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DI
UNTIL APP
AS FOLL

PLAN 8



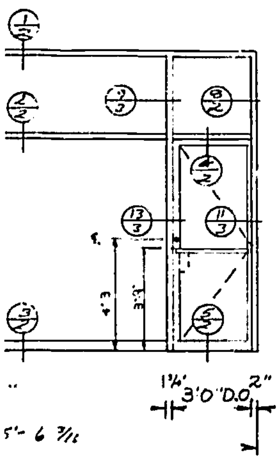
BEAUTY SALON @ WEST ELEV.

HARDWARE SET #3

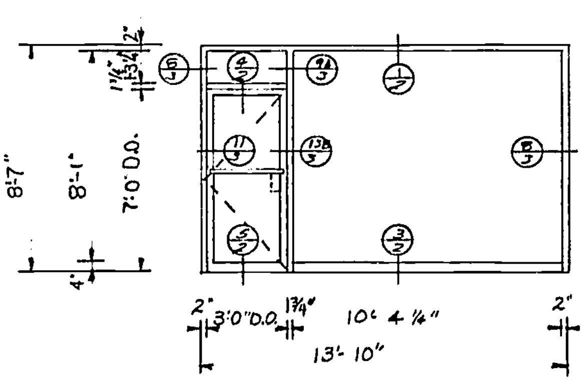


RENTAL AREA #6 @ WEST ELEV.

HARDWARE SET #3

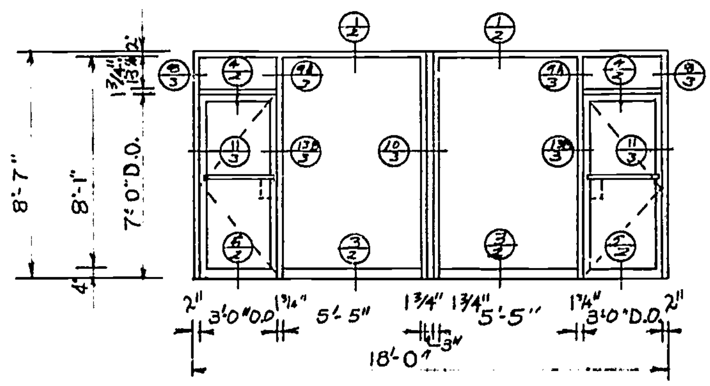


SET #3



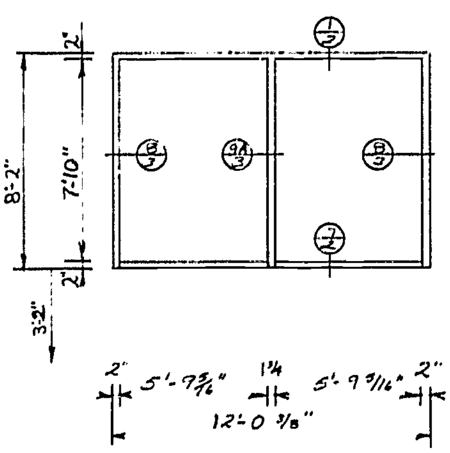
2-REQUIRED
1 @ RENTAL AREA #3 @ WEST ELEV.
1 @ RENTAL AREA #4 @ WEST ELEV.

HARDWARE SET #3



RENTAL AREAS #1 & #2 @ WEST ELEV.

HARDWARE SET #3



4-REQUIRED

@ WEST ELEV.

HARDWARE SET #2

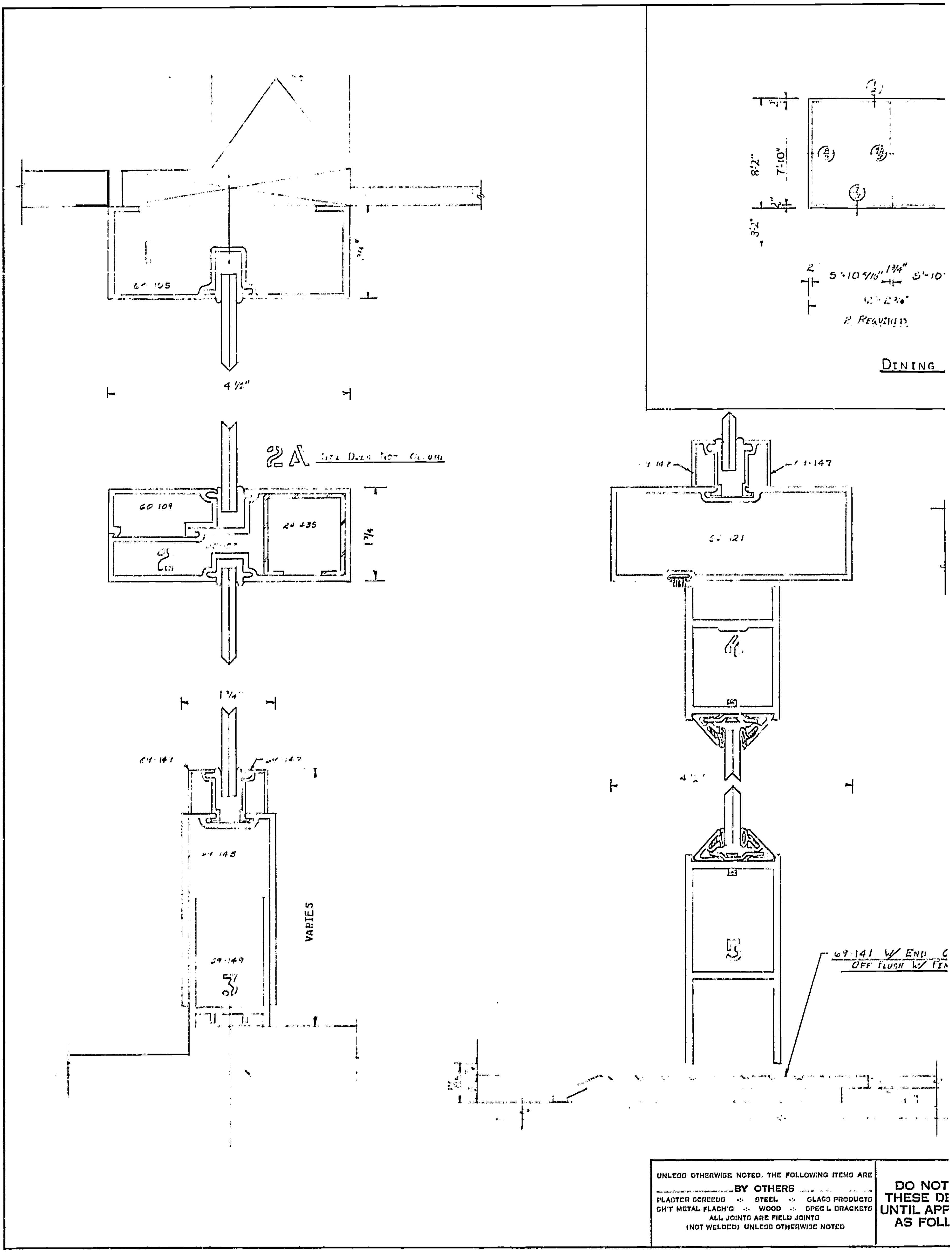
Pair Of Doors
HARDWARE BY KAWNEER #1

QTY.	NUMBER	DESCRIPTION
1	RIXSON #28	FLOOR CHECKS
1	69-141	THRESHOLD
—	—	" COVER PLATE
—	—	DEAD LOCK W/
—	—	FLUSH BOLTS
—	—	PUSH
1	"A"	PULL HANDLE
1	KAWNEER	PANIC EXIT DEVICE

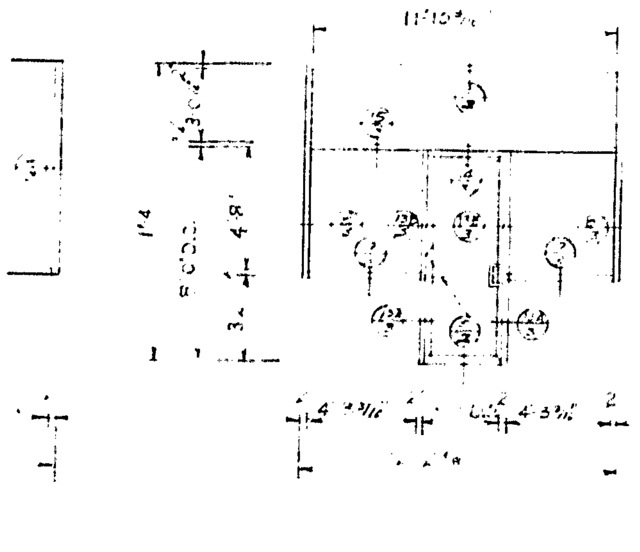
Single Door
HARDWARE BY KAWNEER #2

QTY.	NUMBER	DESCRIPTION
2	RIXSON 28	FLOOR CHECKS
1	69-141	THRESHOLD
—	—	" COVER PLATE
—	—	DEAD LOCK W/
—	—	FLUSH BOLTS
—	—	PUSH
2	"A"	PULL HANDLE
2	KAWNEER	PANIC EXIT DEVICE

NOTE: VERIFY ALL DIMENSIONS IN THE FIELD

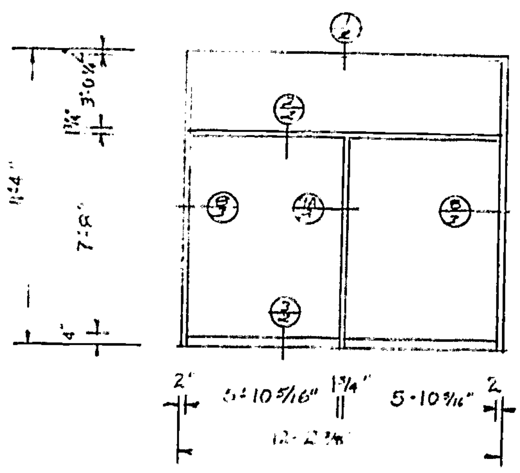

2A
4 1/2"
1 3/4"
VARIES
8'2"
7'-10"
DINING
69-141 W/ END
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DE
UNTIL APP
AS FOLL

PLAN 9

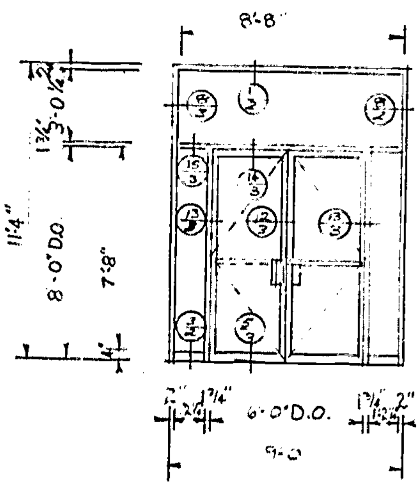


Area ... Elev.

Hardware Set #1



North Elev.



East Elev.

Hardware Set #3

Liquor Store

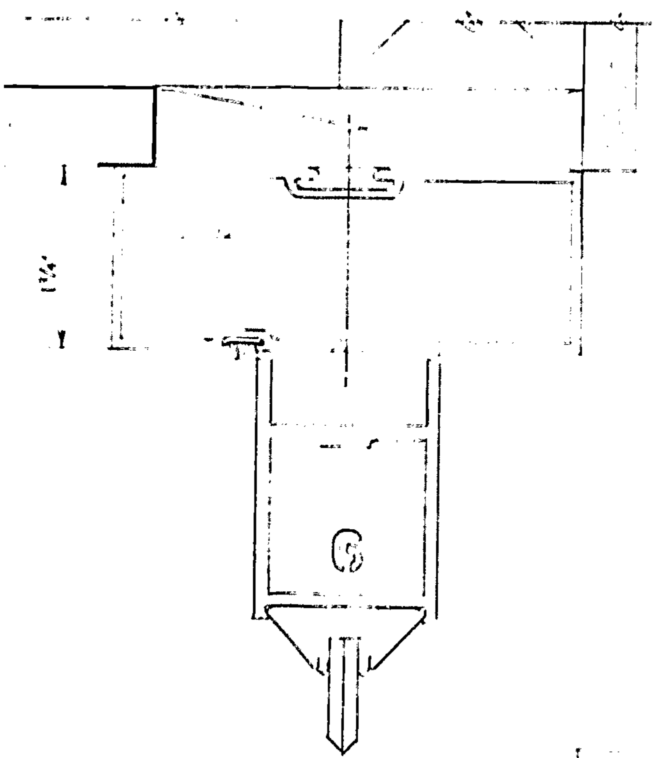
Note: Verify All Dimensions In The Field

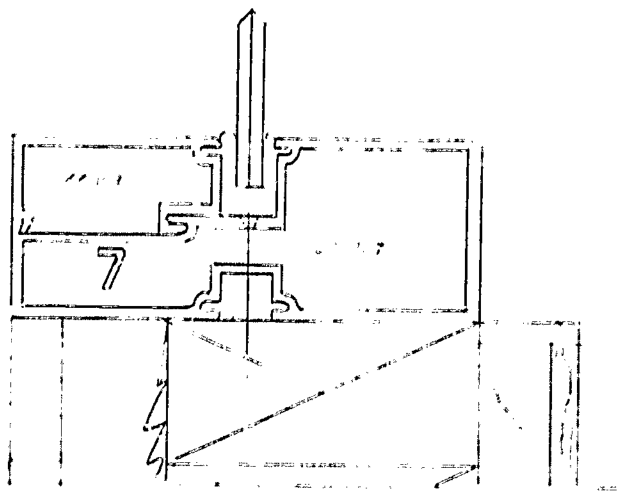
Single Door
HARDWARE BY KAWNEER #3

QTY.	NUMBER	DESCRIPTION
1	RIXSON #40	FLOOR CHECKS
1	[illegible]	THRESHOLD
—	—	" COVER PLATE
1	ADAMS RITE MS 1851A	DEAD LOCK W/
—	—	FLUSH BOLTS
1	"C"	PUSH BAR
1	"C"	PULL HANDLE

Pair of Doors
HARDWARE BY KAWNEER #4

QTY.	NUMBER	DESCRIPTION
2	RIXSON #40	FLOOR CHECKS
1	69 141	THRESHOLD
—	—	" COVER PLATE
1	ADAMS RITE MS 1851A-II	DEAD LOCK W/ TWO WAY LOCK
—	—	FLUSH BOLTS
2	"C"	PUSH BAR
2	"C"	PULL HANDLE





USE DETAILS APPROVED ...OWS

APPROVED FOR DESIGN
DATE
SIGNATURE
TITLE
COMPANY
AS DETAILED ( )
WITH CORRECTIONS ( )

APPROVED FOR DIMENSIONS
DATE
SIGNATURE
TITLE
COMPANY

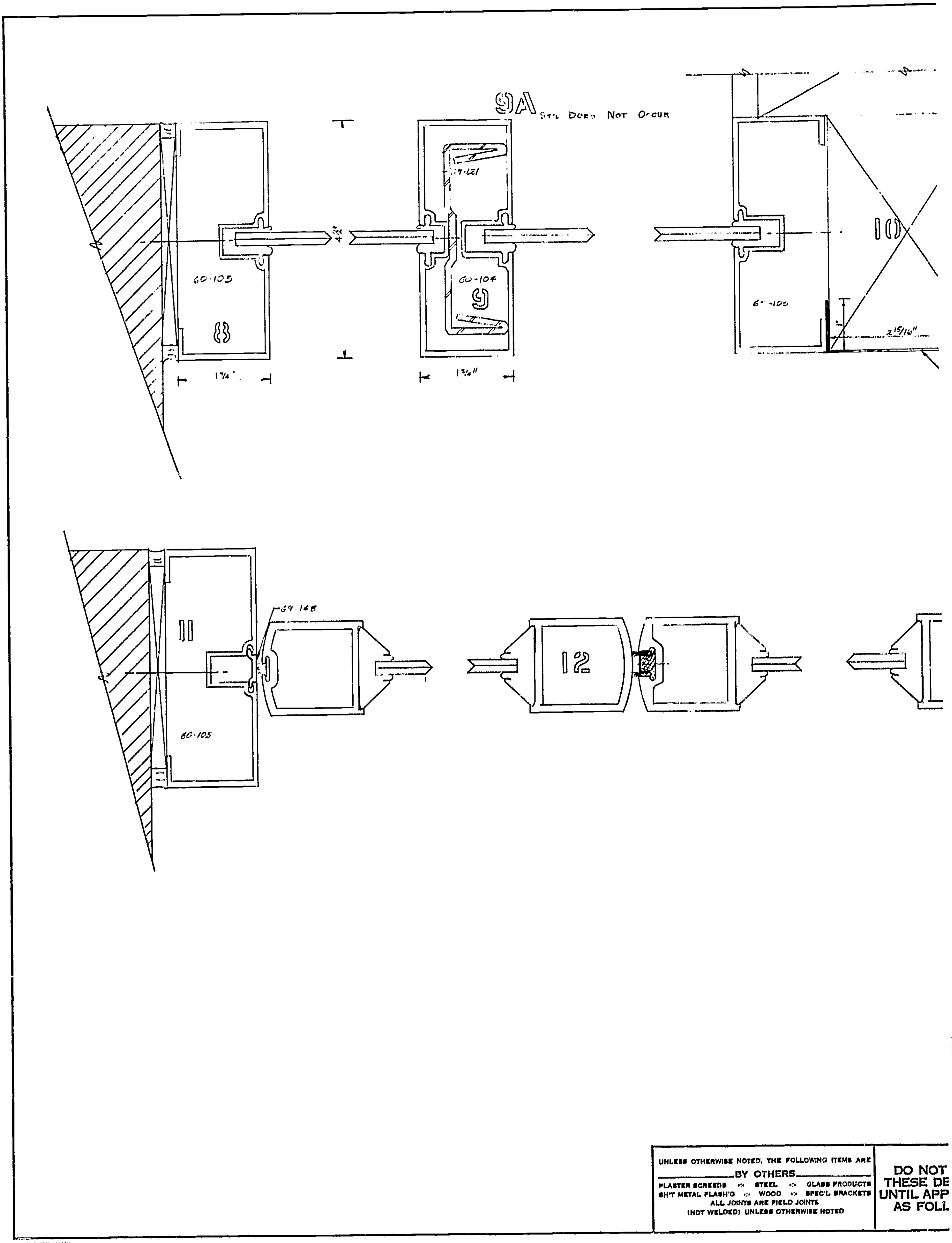
LET | REVISION | BY | DATE

NAME Magnolia Shopping Center
Goleta, Calif.
ARCHITECT ... Vi... A.I.A.
Santa Barbara, Calif.
CONTRACTOR Santa Barbara Glass Co.
Santa Barbara, Calif.

MAT Aluminum
FIN Alcoa 204 A1 R1
DRAWN ... DATE 10-?? 64
CHECKED ... DATE
APPR. DATE

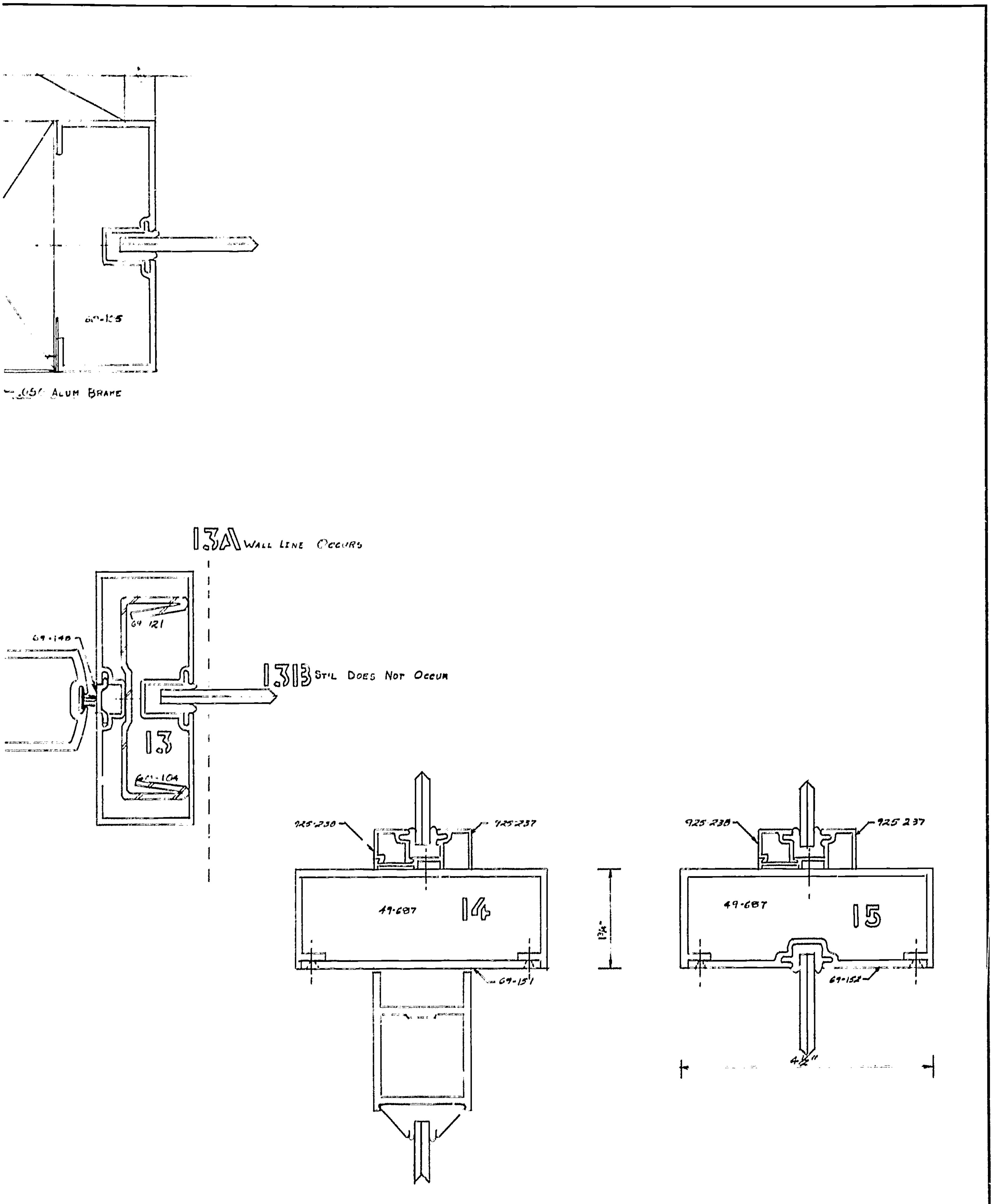
Kawneer COMPANY
RICHMOND, CALIFORNIA
ORDER L-4559
SHEET ... OF ... JOB 64-289

PLAN 9



9A
ST'L DOES NOT OCCUR
60-105
8
1¾"
60-104
9
1¾"
2 15/16"
10
64-148
11
60-105
12
UNLESS OTHERWISE NOTED, THE FOLLOWING ITEMS ARE
BY OTHERS
PLASTER SCREEDS · STEEL · GLASS PRODUCTS
SH'T METAL FLASH'G · WOOD · SPEC'L BRACKETS
ALL JOINTS ARE FIELD JOINTS
(NOT WELDED) UNLESS OTHERWISE NOTED
DO NOT
THESE DE
UNTIL APP
AS FOLL

PLAN 10



USE
ETAILS
ROVED
OWS

APPROVED FOR DESIGN
DATE
SIGNATURE
TITLE
COMPANY
AS DETAILED ☐
WITH CORRECTIONS ☐

APPROVED FOR DIMENSIONS
DATE
SIGNATURE
TITLE
COMPANY

LET | REVISION | BY | DATE

NAME MAGNOLIA SHOPPING CENTER
GOLETA, CALIF.
ARCHITECT HALL & VISIONI A.I.A.
SANTA BARBARA, CALIF.
CONTRACTOR SANTA BARBARA GLASS CO.
SANTA BARBARA, CALIF.

MAT ALUMINUM
FIN ALCOA 204 A1,R1
DRAWN LEG O. DATE 10-22-'64
CHECKED EDB DATE
APPR. DATE

Kawneer COMPANY
RICHMOND, CALIFORNIA
ORDER L-4559
SHEET 3 OF 3 JOB 64-289

PLAN 10

UNIT E

Tools and Equipment

TOPIC 1--TOOLS FOR MEASUREMENT AND LAYOUT

This topic, "Tools for Measurement and Layout," is planned to help you find answers to the following questions:

- Why is the proper selection and use of measurement tools important to the glazier?
- What measurement tools are commonly used in the glazing trade?
- How are glazier's measurement tools used and maintained?

If the glazier is to produce first-class work, he must know how to select and use the correct tools and equipment for the job, since a finished glazing job must not only be pleasing in appearance but must also be true and accurate. The glazier must know how to use and maintain many types of measuring tools. This is an essential requirement if his work is to meet the high standards for accuracy that apply in the glazing trade.

Measuring Tools Used in the Glazing Trade

Among the measuring tools commonly used in the glazing trade are tape rules, folding rules, lip rules, slip sticks, straightedges, squares, levels, and transits.

The tape rule. The tape rule is a measuring tool that can be carried easily in the mechanic's pocket or tool box (Fig. E-1). The typical tape rule has a 1/2-in. blade with a white face and black numbers. The blade is contained in a strong, lightweight, alloy-metal case and is attached to a return spring. The tape rule used most commonly in the glazing trade is 10 ft. in length; 8-ft. and 12-ft. tape rules are also available. The 12-ft. rule is more useful in a 3/4-in. width, which is more rigid and can be extended farther without buckling.

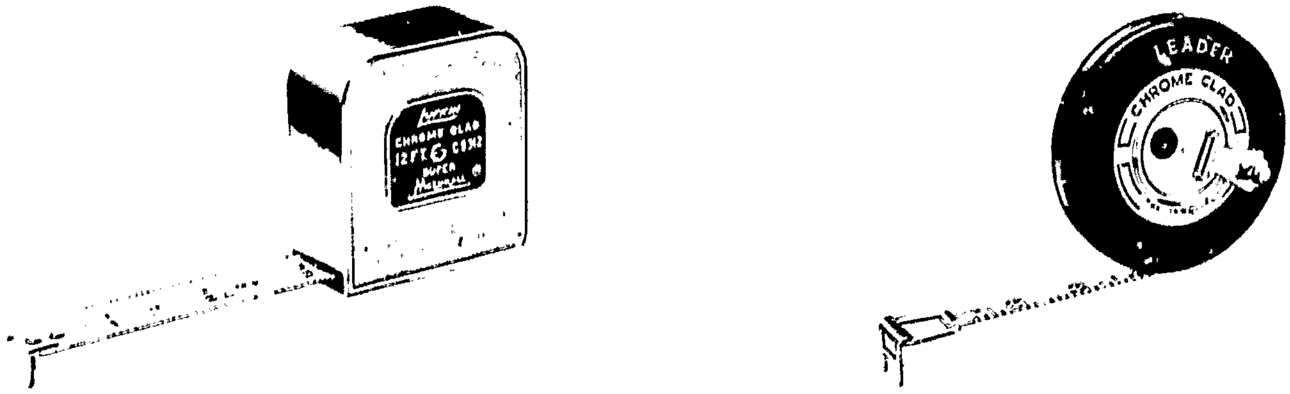


Fig. E-1. Tape rule (left) and steel tape (right)

When a tape rule is selected, the glazier should remember that the poorer quality rules may not be accurate. The measurement of any new rule should be checked before it is used. The construction of the case should also be considered. The standard case in use today has a net length of 2 in., but the glazier should check any rule he buys to confirm this measurement. He should add 2 in. when he is using the rule to obtain an inside measurement. For example, if the exposed numbers on the face of the tape show 3 in. when an inside measurement is being made with the tip of the rule on one point and the back of the case against the other point, the actual distance measured is 5 in., not 3 in.

A tape rule should have a lip at the end that either turns to the side or is slotted to recess flush with the blade end; otherwise, inside measurements will be made inaccurate by the thickness of the lip.

Caution should be taken not to drop the tape rule; dropping always shortens the life of the case, which is strong but not indestructible. Also, the blade is made of very thin tempered steel and will crack if stepped on or folded over sharply. Wiping the tape occasionally with a light coat of oil will improve its readability. Steel measuring tapes of the type illustrated in Fig. E-1 are available in lengths of 25 ft. or more for measuring relatively long distances.

The folding rule. The folding rule, sometimes called the "zigzag" or "ziggy" rule, may be used in determining inside measurement up to 6 ft. 6 in., although it has largely been replaced in glazing work by the tape ruler. The folding rule is made of hardwood, with brass pivot joints and an extension slide 6 in. long. Care should be taken when folding up a rule of this type, since the pivoted ends can be broken easily. Light oiling of the pivots lengthens the life of the rule. A folding rule is shown in Fig. E-2.

The lip rule. The lip rule is of great assistance to the glazier in making accurate measurements for cutting glass (Fig. E-3). The rule is made of hard maple, with ends that are fitted with brass. A lip extends past the zero point on the scale so that when the lip of the rule is caught over the edge of the glass, the measurement starts from exact zero. Wooden lip rules are manufactured in lengths up to 144 in.

A good cutter or inside man will always hang the lip rule on a peg, so that there will be less chance of its being bent. Wiping off the surfaces of the rule during and after use will keep small glass chips from becoming imbedded in the wood and scratching when the rule is laid upon glass. Care should be taken not to drop maple rules, as the hardwood may split. If a lip rule becomes warped or bent, it can no longer be used to cut a straight line. The glazier should not try to straighten such a rule himself, but should take it to a shop equipped to true up the edge correctly.

The straightedge. A straightedge, as the name suggests, is a tool used by the glazier to obtain a straight edge when he is cutting glass. Measurements are not indicated on a straightedge. This tool, which is made of laminated wood or hard maple, should be given the same care that is given to a lip rule, so that it will remain true and straight and free from imbedded glass. A straightedge is used more often at the glass cutting table than on the job site.

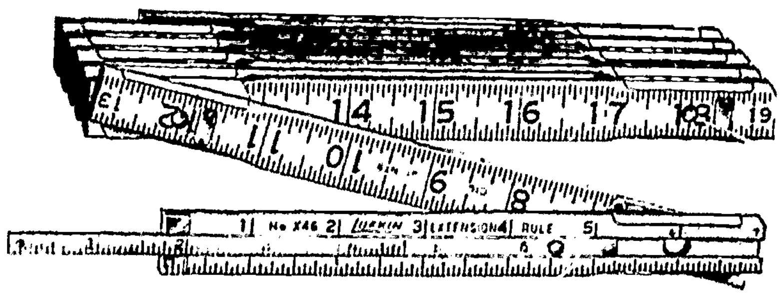


Fig. E-2. Folding rule

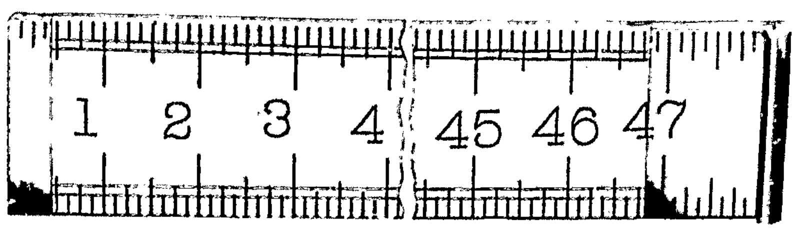
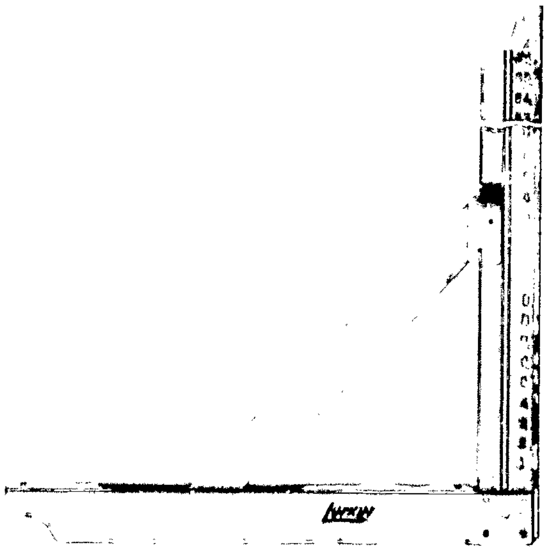


Fig. E-3. Lip rule

The L square. The L square is used mostly around the cutting table, but it can be used wherever a square is required (Fig. E-4). The common L square used in cutting glass is made of selected straight-grain hard maple. Wooden squares are more desirable for use in glazing work than steel squares, as wood is less apt to scratch glass. These squares are thoroughly kiln dried before they are finished. The finish keeps the square straight and true. Reinforced corners and sideplates of brass also help ensure accuracy. As the "stock" or base of a square receives the most abuse, it is made of heavier material, and the side that comes in contact with sharp edges of glass is faced with a continuous plate of brass. The straight or "blade" side of the square is marked in inches on both sides with deep lines and figures for easy reading. The L squares are available in four popular sizes: 24, 36, 48, and 60 in.

Fig. E-4. L square



When a maple L square is used, the base of the square must be held tightly against the material to be checked. If the base rocks on the edge of the glass, the square will not measure the adjoining side accurately. Care should be taken when bringing the base up to the glass to prevent the brass facing from causing "clams" or chips on the edge of the glass.

A wooden square must never be allowed to fall to the floor; this will destroy its accuracy and thus make it useless. Also, if the square is allowed to fall sideways too often, the blade (which is made of quarter-inch maple 3 in. wide) will soon begin to split down from the tip, which has no brass reinforcement. If the blade should split, it must be glued correctly or shortened by being cut off to a point past the split. The split must not pass the sideplates attached

to the corner brace; if this happens, the wooden square is ruined. If a maple square has become "out of square" by long use, it is best to take it to a qualified shop to be squared.

Maple, no matter how straight grained, sometimes acquires small slivers on the edges; when these appear on the tool, they should be removed to keep the straight edge of the cutting side of the square in good condition. Like straightedges and lip rules, L squares should be kept free of small pieces of glass that could become imbedded in the wood.

The combination square. The combination square is available in two sizes: the most commonly used size has a 1-in. by 12-in. blade with a scale reading down to 1/64 in.; a 1-in. by 6-in. square is also used (Fig. E-5). A combination square has an adjustable head with two precision-ground surfaces. One side of the head forms a 90° angle with the blade; the other side forms a 45° angle with the blade. The adjustable head slides the full length of the scaled blade, or within certain limits on the blade, depending on the manufacturer. A knurled lock nut allows the sliding head to be secured at the desired point along the blade.

The combination square can be used to measure depth or to mark cuts; for example, with the head set at 1 in. on the scaled blade, a 1-in. line can be scribed or a 1-in. depth checked. When the glazier is working with store front materials, the combination square is a useful tool for checking 45° mitered cuts and 90° square cuts. The combination square is also equipped with a level bubble, which is very useful in checking the level of small surface areas such as hinges or brackets. Wiping down the scale with light oil prevents rusting and keeps it readable for the life of the square. The combination square is a precision tool and must be handled accordingly; like the L square, it can be made useless by dropping.

The angle divider. The angle divider, a precision instrument made of polished steel, is used by the glazier mainly to establish or bisect angles on glass store front materials (Fig. E-6). The angle divider can be used to establish both inside and outside angles. A set screw allows the user to set the divider to any desired angle within its range. The tool cannot be used to measure the degrees of an angle--a protractor is required for this--but it is most useful for scribing materials into corners and for the repeated marking of the same angle on many pieces of material.

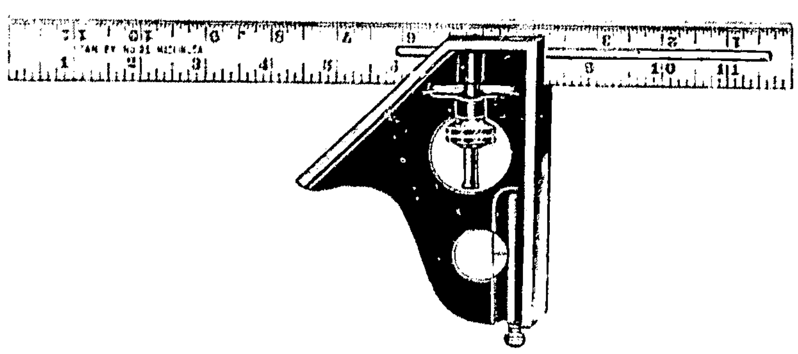


Fig. E-5. Combination square

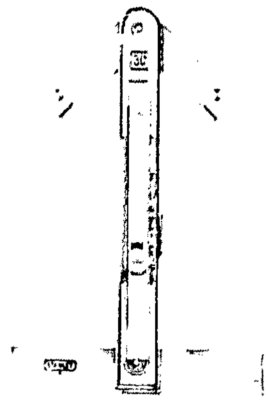


Fig. E-6. Angle divider

The T bevel. The T bevel, or miter square, consists of a sliding blade and a handle with a lock nut to set the blade. It is used to find and hold any desired angle (Fig. E-7). If the glazier is checking or scribing an angle or bevel, he must use a protractor in conjunction with this tool; the T bevel has no degree markings. Some T bevels are made of steel and wood; others are made entirely of steel.

The spirit level. The spirit level is used in many types of glazing work for checking the plumb or level of mirrors, walls, jambs, headers, floors, and so forth (Fig. E-8). The most popular type of spirit level is made from a strong, light metal alloy. Spirit levels used in the glazing trade vary in length from the 6-in. pocket type to the 72-in. extra long type, and incorporate two or more bubble vials. The 36-in. metal level is the most useful type, although 18-in. and 24-in. metal levels are more suitable for carrying in the tool box. A carrying case or box is useful in maintaining the accuracy of a good level.

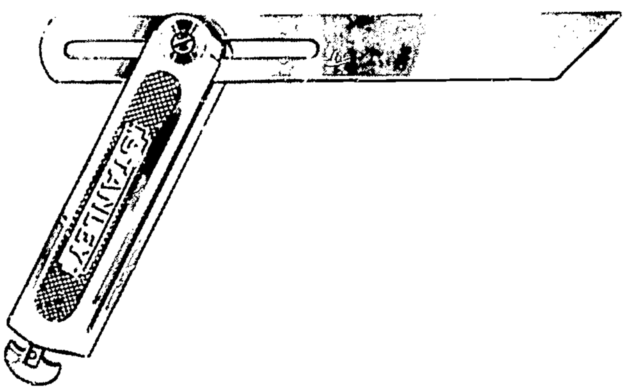


Fig. E-7. T bevel (miter square)

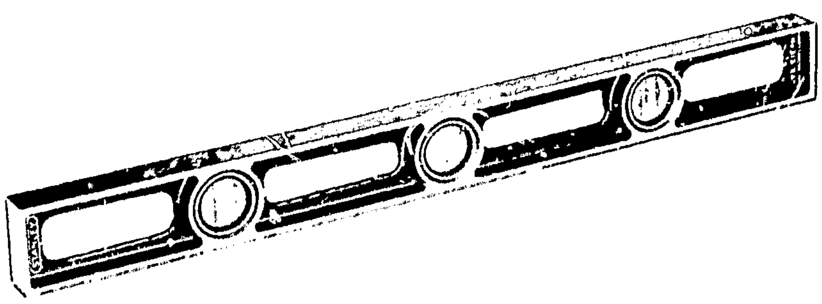


Fig. E-8. Spirit level

A level should be checked occasionally on a level surface or with another level that is known to be correct. If one of the bubbles proves to be inaccurate, it should be marked with a dot or touch of paint as a reminder not to use it. If a level becomes warped or bent, it is no longer useful. Dropping a level can crack the frame, break the glass, or affect the accuracy of the bubbles.

Water level. A water level (not shown) may be used to establish two level measurements in different rooms or on different walls. Since glaziers no longer do a great deal of interior structural work, this tool is used less often than was once the case. The level consists of a piece of hose about 40 to 50 ft. long with a glass gauge tube at each end. When a water level is used, it is filled with water and one gauge is placed at the desired level on one wall; the remote end is then raised or lowered until the two gauge markings are the same.

When two points are checked for level with a water level, care should be taken to see that there is no air in the line; if there is, any reading taken will be incorrect. Heat on one end of the water level will also cause an error in reading. The accuracy of a water level can be tested by holding the two ends together and checking to see that the reading is the same on both gauges. If a water level is used in a furnished building, care should be taken not to allow the water to run out. This is best prevented by placing the thumb over the

open end of the gauge and keeping it there until the gauges are at approximately the same level. With a little practice, the user can learn to remove his thumb from the open end for an instant, and if the water begins to rise on the gauge, replace his thumb immediately over the end of the tube gauge. The end should be raised slightly before the thumb is removed again, or lowered if the water begins to recede when the thumb is first removed.

Transit. The transit is a measuring tool used to establish the horizon level marks from which job layouts are determined (Fig. E-9). It is very useful in the layout of structural glass store fronts, and it can also be used to good advantage on jobs requiring extended horizontal tube construction. Once it is set up, the transit will establish level measurements over a 360° swing.

The transit is a precision tool and should be handled very carefully to prevent damage to the delicate setting parts. It should always be stored in a carrying case. If the transit becomes damaged, it should be repaired by a qualified mechanic.

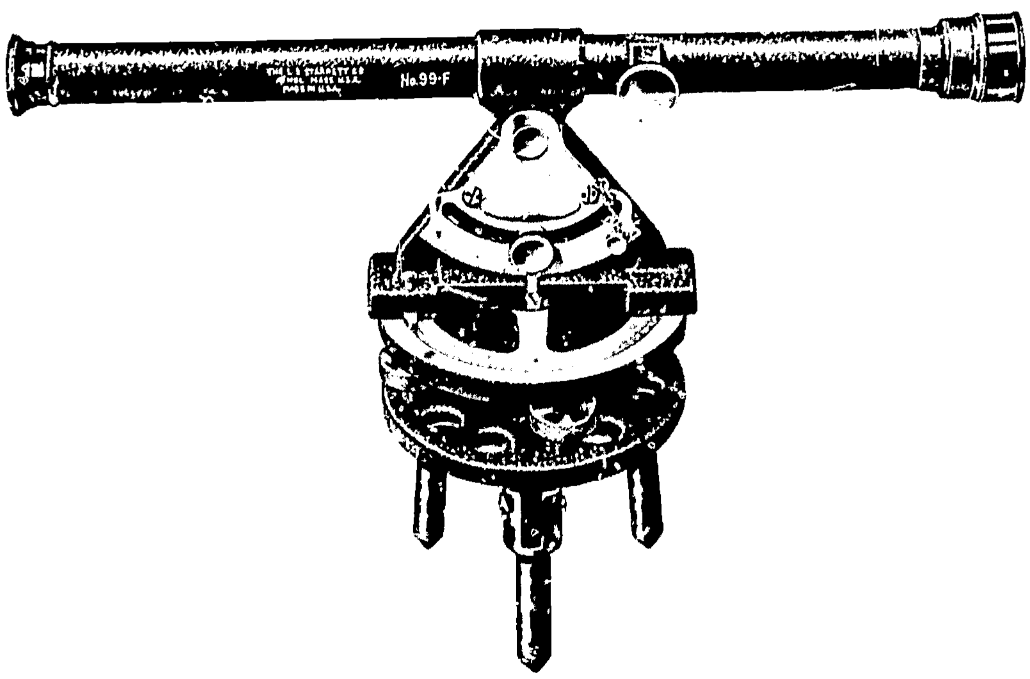


Fig. E-9. Transit

Slip stick. The slip stick is a versatile tool that simplifies a number of measurement and layout operations in glazing work (Fig. E-10). It can be used for making inside and outside measurements, and it is especially useful for such difficult operations as overhead measurement and measurement for the installation of large lights of glass. Using this tool, the glazier can perform many operations of this type quickly and accurately without a helper.

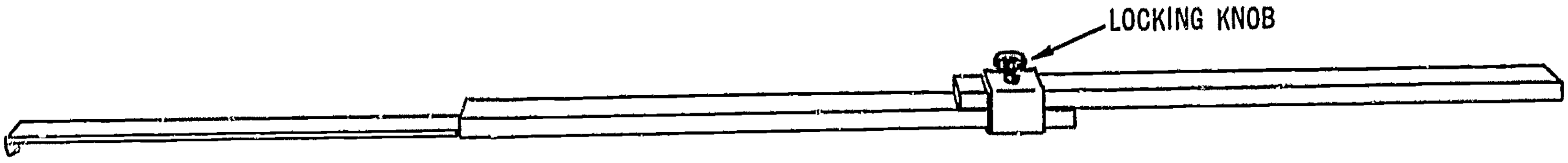


Fig. E-10. Slip stick

The slip stick is a light-weight precision rule, typically consisting of three extendable graduated sections in extruded frames and incorporating a durable locking knob and stainless-steel hardware. A typical slip stick can be used for measurements in the range of 50 in. to 144 in. The tool should be carried and stored in its case. In measuring a wide horizontal span where the slip stick cannot be supported by a surface, it is best to hold the tool on edge rather than flat; this will prevent flexing.

Study Assignment

Examine catalogs and other sales literature describing tools for measurement and layout. Such publications will be found in your classroom library.

UNIT E--TOOLS AND EQUIPMENT

TOPIC 1--TOOLS FOR MEASUREMENT AND LAYOUT - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The 2-in. width of the tape-rule case should be added to __1__ measurements.	1. ________
2. The scale faces of steel measuring tools should be __2__ with __3__ occasionally to preserve readability.	2. ________ 3. ________
3. The glazier's lip rule is made of __4__.	4. ________
4. When the lip rule is not in use, it should be __5__ on a __6__.	5. ________ 6. ________
5. It is important that the glazier keep wooden measuring tools free from __7__ __8__, which tend to scratch the surfaces being measured.	7. ________ 8. ________
6. A straightedge differs from a rule in that it has no __9__.	9. ________
7. Wooden squares and straightedges are preferable to metal types for glass work because they have less tendency to __10__.	10. ________
8. If an L square splits beyond the __11__, it is unusable.	11. ________
9. The most useful and most widely used spirit level for glazing work is __12__ long.	12. ________
10. For leveling widely separated indoor points, the glazier sometimes uses a __13__ __14__.	13. ________ 14. ________
11. If an angle is to be checked or scribed repeatedly, the glazier should use an __15__ __16__.	15. ________ 16. ________
12. Establishing levels in store front work is usually done with a __17__.	17. ________

13. The slip stick is very useful for the measurement of __18__ openings.

14. When it is used for measuring a wide horizontal span, the slip stick should be held on __19__.

15. In measuring large openings with the slip stick, the glazier can often work without a __20__.

18. ____________

19. ____________

20. ____________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. A wooden square with a slivered edge cannot be repaired. — 1. T F
2. A 12-ft. tape rule should have a 3/4-in. wide blade. — 2. T F
3. The standard net length of a tape-rule case is 2 in. — 3. T F
4. The tape rule is replacing the folding rule in glazing work. — 4. T F
5. When measuring with the lip rule, the glazier must allow for the length of the lip. — 5. T F
6. A warped lip rule or straightedge can be straightened on the job with a pair of hand screw clamps. — 6. T F
7. If a maple L square is split below the corner brace, it cannot be repaired. — 7. T F
8. The angle divider is an aid to scribing the same angle on many pieces of material. — 8. T F
9. The T bevel is marked from 0° to 90°. — 9. T F
10. The slip stick is more useful for measuring large openings than the folding rule. — 10. T F

UNIT E--TOOLS AND EQUIPMENT

TOPIC 2--CUTTING TOOLS

This topic, "Cutting Tools," is planned to help you find answers to the following questions:

- What tools and equipment are used for the cutting of glass?
- What is the most widely used glass cutter?
- How are holes, notches, corners, and irregular shapes cut in glass?

The glass cutter, one of the most frequently used of the glazier's tools, is manufactured in many sizes, shapes, and qualities. The choice of cutter to be used depends largely on the glazier's individual requirements and work habits, but regardless of the cutting tool he selects for a given application, the glazier must be able to use the tool with skill and confidence. Once the score has been made on a piece of glass, it cannot be erased or corrected. It must be right the first time.

The life of any type of glass cutter depends upon the care it is given. All moving parts should be correctly lubricated when cutting is being done, and the tool should be kept clean and dry when it is not in use. The glazier may use several types of glass cutters, many of which are discussed in this topic.

The Wheel Glass Cutter

The wheel glass cutter is the cutter most commonly used in the glazing industry (Fig. E-11). It consists basically of a wheel, head, and shank or handle. The wheel is usually made of tempered high carbon steel, and includes a bronze bearing. The head of the glass cutter is notched on one side for breaking small cuts in the range of 1/8 in. to 1/4 in. The handle is made of cast iron or wood. The wheels on some cutters can be removed and replaced. If a glass cutter with a nonreplaceable wheel does not work properly, it should be thrown away; the expense involved in repairing or sharpening it would be more than the value of the cutter. A good glazier makes a practice of carrying extra cutters in his tool box.

The wheels of these cutters range in diameter from 1/8 in. to 1/4 in. The diameter of the wheel determines the use for which the cutter is best suited, such as all-purpose cutting or cutting plate glass, hard glass, or odd shapes. the 3/16 in. (or 02) cutter is the general purpose cutter; it is the one used most frequently by glaziers. When the 02 cutter is new, it is used for sheet glass; when it becomes too dull for sheet glass, it can generally be used for the softer plate glass. The larger 1/4-in. size wheel is best suited for use on plate and other soft-surface glass. Wheel glass cutters are available with or without a ball knob on the end of the handle. The ball-knob handle is preferred because it can be used to tap the back of a score to start a break.

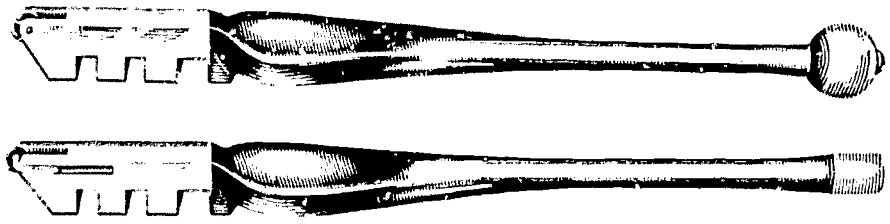


Fig. E-11. Wheel glass cutters

Diamond Glass Cutters

The diamond glass cutter consists of an industrial diamond mounted in the head of a glass cutter that is otherwise similar in appearance to a standard wheel glass cutter (Fig. E-12). The diamond glass cutter is most often used where production cutting is done, as in glass manufacturing. The diamond cutter is expensive and is not practical for glazing on the job, where cutters are easily broken or lost. Various types of diamond glass cutters are made for cutting thin sheet glass, medium thickness glass, and thick glass. Diamond scribers are also in use.

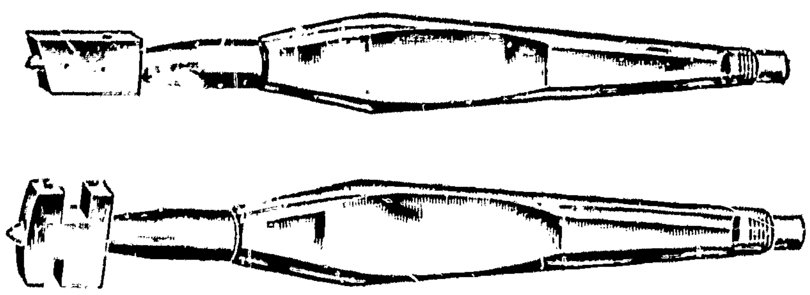


Fig. E-12. Diamond glass cutters

Diamond Cutoff Wheels

The diamond cutoff wheel is very similar in appearance to a conventional radial saw blade, except that the cutting edge consists of a continuous built-up diamond-impregnated bead instead of teeth. Wheel sizes range from 6 in. to 12 in. in diameter. The diamond wheel is invaluable in cutting out corners, notches, and small cutoffs. It is important that the material and the machine be very securely set up so that the material will not bind against the diamond-impregnated edge of the wheel. The work must be run into the wheel true, and plenty of water must continually be run over the cutting edge. Extreme caution should be used at all times in operating machines equipped with diamond cut-off wheels.

Circle Cutters

A circle cutter, which is somewhat similar to a compass, is used for cutting perfect circles for such articles as flashlight lenses, portholes, and round table tops. Two kinds of circle cutters are available, as illustrated in Fig. E-13: one is portable, with a manually positioned pivot; the other is a

stationary machine cutter with a fixed pivot. A typical portable circle cutter consists of a small metal base that incorporates a rubber mat or a suction cup to prevent slipping, an adjustable arm that pivots around the base, and a wheel cutter on the end of the arm. This type of cutter cuts circles from 2 in. to 72 in. in diameter.

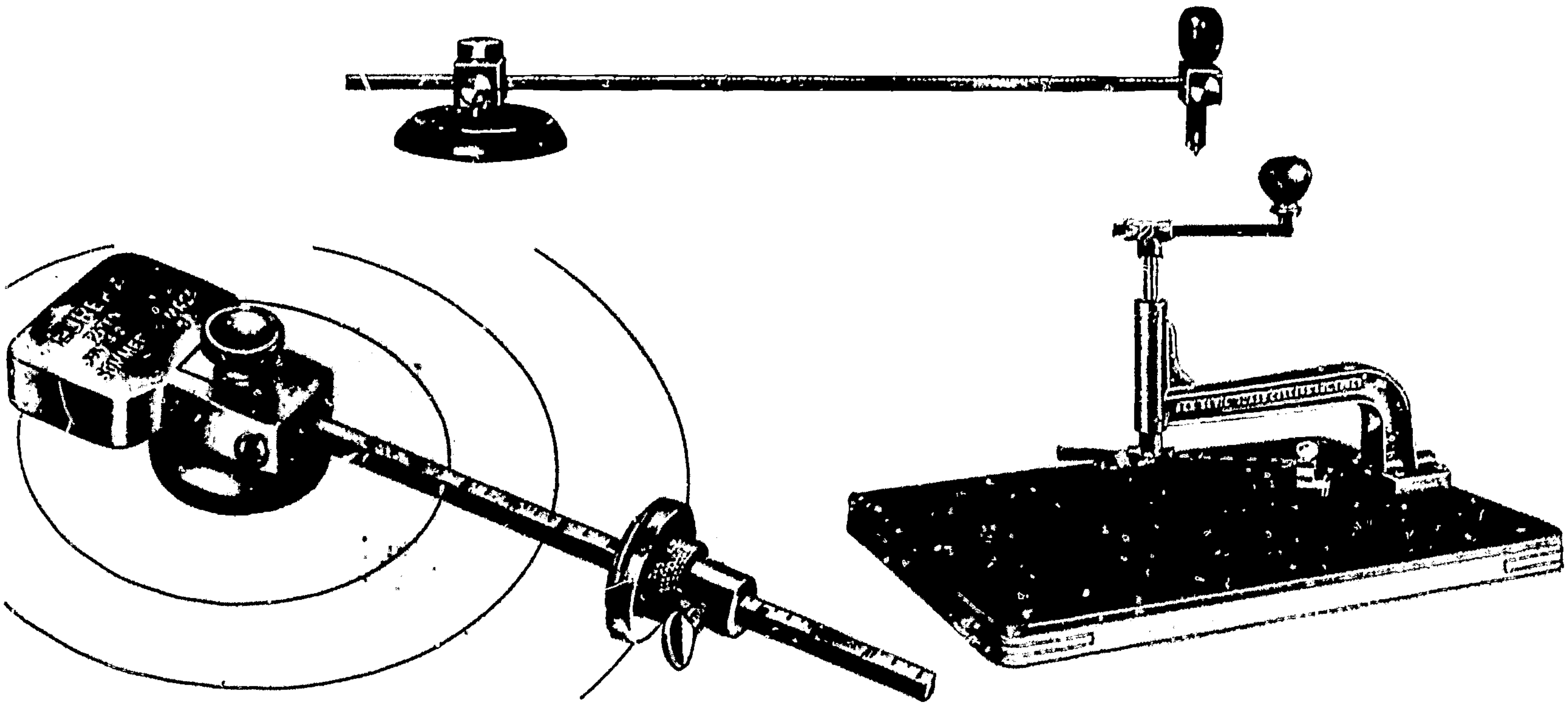


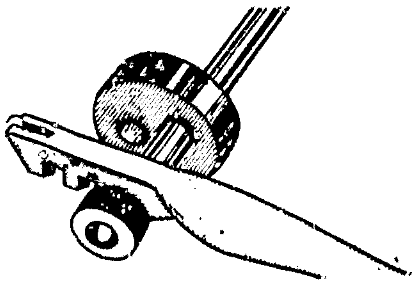
Fig. E-13. Circle cutters

A combination oval and circle cutter is also available. This type of cutter operates on a turret that is mounted on a table. When the glass is to be cut, it is laid on the table, and the arm with the cutter on it is brought down from the turret. A handle on the top of the turret operates the cutter arm.

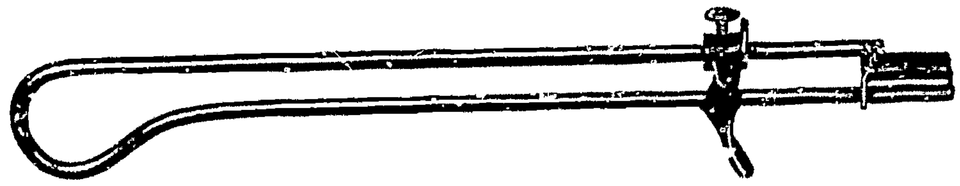
In using any adjustable circle cutter, the settings marked on the bar should not be relied upon; before the final cut is made, the setting of the cutter should be checked on a scrap of glass or on the waste area of the glass to be cut. Also, the glazier should ensure that the cutting heads receive plenty of lubrication and are in good condition.

Glass-Cutting Guides

Glass-cutting guides or gauges used with wheel cutters are designed for production work in which many lights of glass must be cut to the same size. The typical guide illustrated in Fig. E-14 (a) consists of a round metal plate that slides over a long, 1/4-in. diameter bar. A set screw holds the guide plate at the required setting. A notch in the head of the wheel glass cutter fits into a groove on one end of the bar, and a lock nut secures the cutter in place. To ensure accurate work, care should be taken to keep the edge of the guide plate against the edge of the glass at all times. For inside cutting on other than flat glass, a different type of cutting guide, as illustrated in Fig. E-14 (b), is used.



(a)



(b)

Fig. E-14. Glass cutting guides

The Automatic Glass-Cutting Board

The automatic glass-cutting board is used mostly for production cutting (Fig. E-15). After it has been set for cutting glass to one size, as many lights of this size as are required may be cut without further measurement. A typical glass cutting board incorporates two metal rails precisely assembled at a 90° angle to assure a square cut; the side rail has an adjustable slide to which the cutting wheel is attached. Large-size cutting boards have means of adjustment to provide the proper cutting tension for all types of glass. Cutting boards vary in size, the largest being 48 in. wide and 69-5/8 in. high.

The Pattern Cutter

The glass pattern cutter is used for cutting circles, ovals, squares and rectangles with rounded corners, and all kinds of irregular shapes (Fig. E-16). The wheel of the pattern cutter is located on a swivel-jointed arm that extends out over the cutting table, and can thus be moved over the glass in any direction. The cutting wheel is mounted on the bottom of a screw-adjustment handle at the end of the arm. The screw adjustment allows the correct tension to be set for cutting any type of glass. Pattern cutters can cut corners to a radius as small as 3/8 in. The larger cutters of this type can cut glass in any shape or size from 2 in. square to 36 in. square.

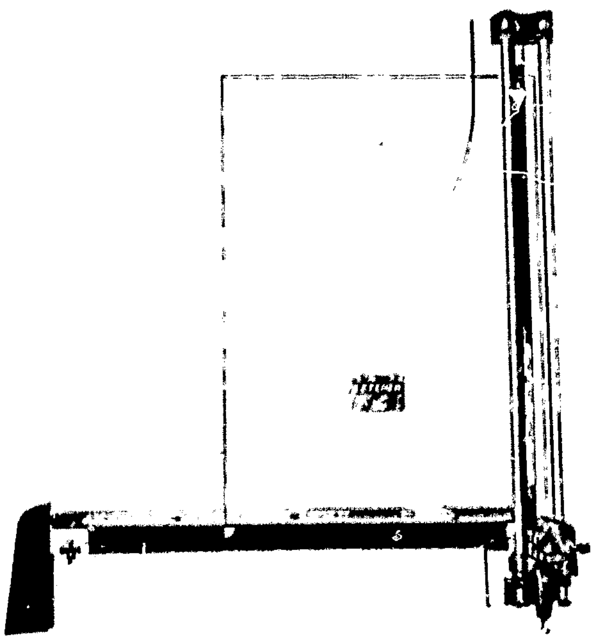


Fig. E-15. Automatic glass-cutting board

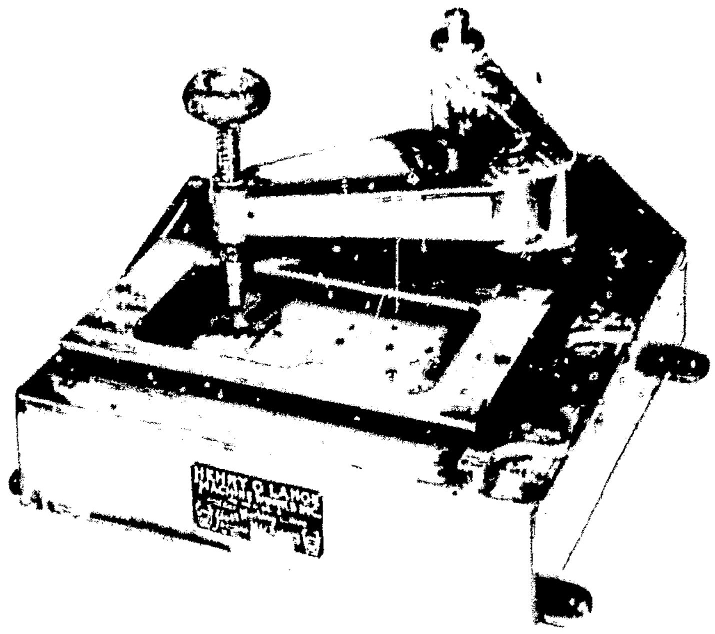


Fig. E-16. Pattern cutter

Glass Drills

A glass drill is a tool specially designed for cutting holes in glass. Although three-cornered files are still in use for this purpose, most glaziers find that drills with carbide or carboloy tips brazed to the point and ground to the desired shape are more durable and do the job faster. Such drills are available with two or three cutting edges (Fig. E-17).

When using a glass drill, keep two important rules in mind: the drill will not cut glass unless turpentine or commercial coolant are used, and the drill must not be misused or abused. The point is made of very hard steel, but it is brittle and will chip or break if the drill is misused.

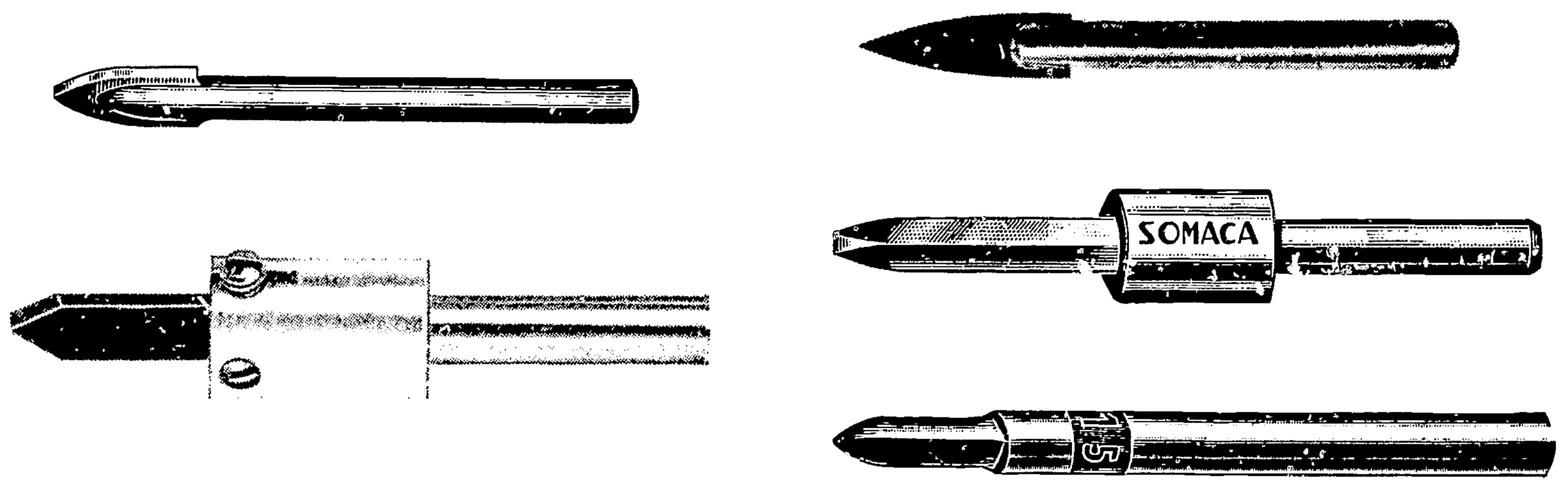


Fig. E-17. Glass drills

If a hole larger than 1/2 in. in diameter is to be drilled in glass, a tube drill (hole saw) should be used. Tube drills can be used to cut holes of various sizes in tile, marble, or ceramics, as well as glass. A typical drill of this type is simply a brass tube in which vertical slots have been cut; these slots provide means for feeding carborundum abrasive and water to the work during the drilling operation. The tube grinds through the glass as it rotates. In another type of tube drill, the bottom 1/4 in. or 1/2 in. of the tube is diamond impregnated; no abrasive is required in using this drill, but a coolant must be used in the drilling operation.

Care should be taken to handle and store tube drills so that they will not be crushed or bent. Any out-of-roundness will cause the drill to run off center. Unless the drill runs perfectly true, it may either break the glass or be thrown out of the drill head. Also, if the drill is not held at a 90° angle to the material, it will not come through cleanly and smoothly. A drill press should be used rather than a portable drill with tube drills.

The Sandblaster

Sandblasting tools are important in the glass business, but they are not commonly used by the glazier. Except in some of the largest glazing shops, sandblasting is generally left to outside specialists. The sandblaster is used to

cut notches and make other cutouts that can be made only with great difficulty using other cutting tools. When a sandblaster is used, the glass areas to be protected are masked with a rubber compound; then the sand is blown with great force upon the glass to cut away the uncovered area. A cutout is thus produced with edges and inside corners that are clean and free from invisible runs. Care must be taken in using a sandblasting machine to direct the concentrated stream of sand and air only at the area to be cut, not toward persons, equipment, or other exposed glass areas.

Study Assignment

Examine catalogs and other sales literature describing glazier's cutting tools. Such publications will be found in your classroom library.

UNIT E--TOOLS AND EQUIPMENT

TOPIC 2--CUTTING TOOLS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Lubrication of moving parts is essential in using __1__ type glass cutters.	1. ________
2. The diamond glass cutter is used mostly for __2__ cutting.	2. ________
3. Diamond cutoff wheel edges must be __3__ cooled and lubricated while cutting.	3. ________
4. The wheels of glass cutters are made of tempered, high __4__ steel.	4. ________
5. A pattern cutter can cut corners to a radius as small as __5__.	5. ________
6. The __6__ of a pattern cutter has __7__ joints.	6. ________ 7. ________
7. Tube drills must be handled carefully to prevent their being __8__ or __9__.	8. ________ 9. ________
8. The abrasive mixture used with a conventional slotted tube drills is __10__ and __11__.	10. ________ 11. ________
9. Turpentine or __12__ __13__ must be used in drilling glass with a hard-metal tipped glass drill.	12. ________ 13. ________
10. Complex cutouts in glass are best made with a __14__.	14. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The circle cutter can be used to cut various patterns.	1.	T	F
2. A wheel glass cutter that has become too dull for sheet glass can still be used for plate glass.	2.	T	F
3. The wheels on some glass cutters can be removed for replacement.	3.	T	F
4. The purpose of the ball on the handle of one type of wheel glass cutter is to improve the balance of the tool.	4.	T	F
5. A glass-cutting guide simplifies the cutting of complex patterns.	5.	T	F
6. Diamond cutoff wheels are especially useful in cutting notches, corners, and small cutoffs.	6.	T	F
7. Circles smaller than 5 in. in diameter cannot be cut with a portable circle cutter.	7.	T	F
8. Irregularly shaped pieces of glass are best cut on a pattern cutter.	8.	T	F
9. An automatic glass-cutting board simplifies the cutting of large numbers of equal-sized lights.	9.	T	F
10. Sandblasting is usually done by outside specialists.	10.	T	F

UNIT E--TOOLS AND EQUIPMENT

TOPIC 3--HAND TOOLS AND EQUIPMENT

This topic, "Hand Tools and Equipment," is planned to help you find answers to the following questions:

- What types of common and special-purpose hand tools and equipment are used in the glazing trade, and for what purposes are they employed?
- Why is a quality hand tool less expensive in the long run than an "economy" tool?
- How are hand tools maintained for best service and longest life?

The quality and efficiency of a glazier's work are dependent to a great extent upon his ability to select, use, and maintain correctly the various types of hand tools and related equipment required in the trade. An experienced journeyman will take to the job only the tools he knows he will need to do the work correctly; if a mechanic makes a habit of filling his tool chest with tools he will never use, he will simply be carrying around excess weight.

Selection and Care of Hand Tools

The glazier should never buy "economy" hand tools; one good tool will usually outlast a dozen inferior ones of the same type. Good-quality tools are usually guaranteed; in many cases, if such a tool breaks, the glazier can return the broken pieces to the dealer or factory and get a replacement.

Small hand tools will last for many years if they are given correct care, but if a hand tool is abused--subjected to too much pressure or used in the wrong application, for example--its usefulness will be reduced or it may be ruined. Tools should be cleaned and dried when they are put away after use, and surfaces subject to rusting should be wiped with an oily rag. The specific procedures for maintaining hand tools are given along with the tool descriptions in this topic.

Putty Knives

Putty knives are made with either straight or bent blades (Fig. E-18). The straight putty knife is used for scraping, caulking, and putty-running in wood-sash glazing; it is the general purpose putty knife. Most straight putty knives have stiff blades 1-1/4 in. or 1-1/2 in. wide. Bent putty knives are also used for running putty, especially on steel or aluminum sash. The blades of bent putty knives range from 3/4 in. to 2-1/2 in. in width, depending upon their intended use, and are usually made with sharp or curved bends of 30° to 35°.

All putty knives are made of steel, but some have stiffer blades than others. The flexible or thin-blade putty knife is used mostly for cleaning grooves or

separating miters in replacement work. The finish of a putty knife is made very smooth so that glazing compound and similar materials will slide or clean off easily. A putty knife is of no value to a glazier if it has become rusty or worn or if the edges are no longer straight. A putty knife should never be used as a chisel; such abuse damages the handle and usually ruins the tool.

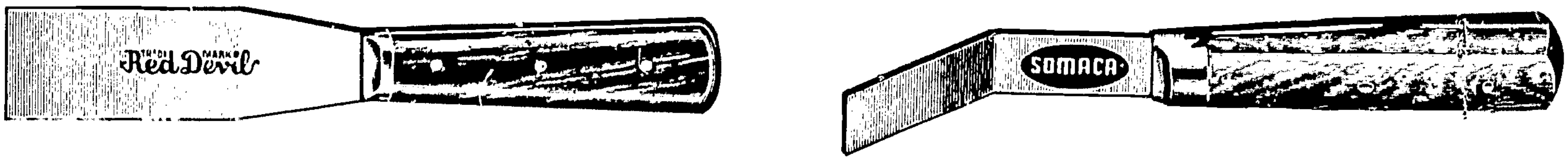


Fig. E-18. Putty knives

Hammers

Hammers are important tools in the glazing trade. In the course of a day's work, a glazier may use a straight claw hammer, a curved claw hammer, or a special glaziers' hammer, which also may be straight or curved. The working faces of the glaziers' hammers are polished to remove any roughness. A glaziers' hammer is shown in Fig. E-19.

A straight claw hammer is just as popular as the curved claw hammer, but the curved claw is generally more satisfactory for pulling nails and for opening cases or boxes of glass. Some glaziers prefer the straight claw for this purpose because it is less likely to chip the glass or split the wood. The glazier should include among his tools a medium-size claw hammer that is light enough for driving small brads but heavy enough for such work as reglazing; a hammer with a weight of 12 to 14 ounces is usually preferred for general-purpose use.

It is very important that the head of any hammer be secured tightly to the handle to prevent it from flying off. The faces and edges of any type of hammer used around glass should be kept polished and free from nicks or burrs to prevent scratching. Remember also that a hammer should not be used as a crowbar.

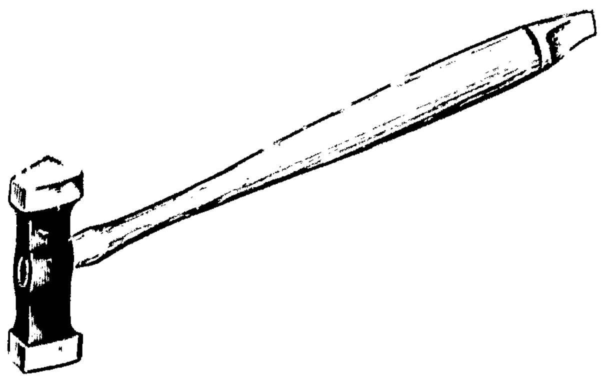
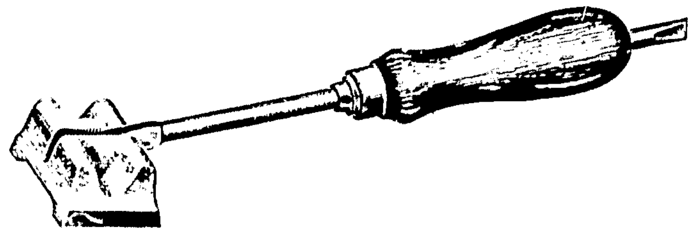


Fig. E-19. Glaziers' hammer

The point-driving hammer, or point driver, is used to drive triangular glazing points into wood sash. It has a special swiveled head with square, flat sides (Fig. E-20). The surfaces of the heads that slide along the glass are ground and polished so that they will not scratch the glass.

Although some glaziers prefer to use a chisel to drive points, this type of hammer offers the advantage of permitting the points to be driven in close to the glass. If the straight and square edge of the hammer's striking surface becomes nicked or dented, it should be ground or filed square again so it will drive a point properly without breaking the glass. The end of a point-driving hammer opposite from the head resembles a screwdriver; this end is used for bending the corners of glazing points so that the glass will be tight in the sash.

Another popular tool for driving points is the automatic point driver shown at the right in Fig. E-20. This tool incorporates a quick-loading magazine for the points, and is available in two types, one for 3/8-in. and one for 1/2-in. points.



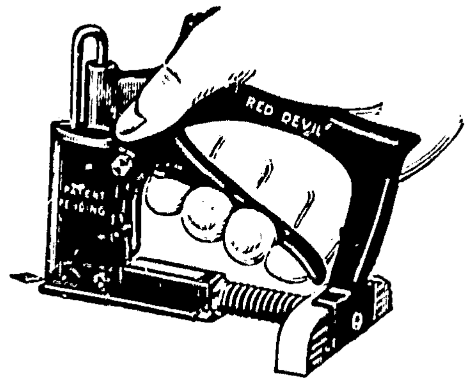


Fig. E-20. Point-driving hammer (left) and automatic point driver (right)

Chisels

Three types of chisels used in glazing work are shown in Fig. E-21. The glaziers' chisel, which is made especially for the trade, is of heavy, one-piece, forged construction. Heavy hammer blows will not damage it, and its rugged construction makes it very useful for such work as lifting plate glass when adjusting setting blocks.

Glaziers often use woodworking chisels with thin blades of widths from 1/4 in. to 1 in. Good chisels of this type are made of fine steel that holds a cutting edge well. A wood chisel is tempered and is not designed for pry-bar work.

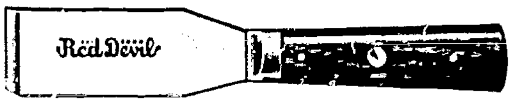
Cold chisels used by glaziers are made of the toughest type of alloy steel and are tempered so that they will stand up under hard use. The cutting edge of a cold chisel should be ground to an angle of about 60°. The head of a chisel must never be allowed to become flared or mushroomed; pieces of the flared head are easily chipped off in hammering, and the flying pieces can cause serious injury. Any flared steel should be ground off before the chisel is used.

A good basic glazing tool kit should include at least one glaziers' chisel; 1/2-, 3/4-, and 1-in. wood chisels; and 1/2- and 3/4-in. cold chisels.

The Hacking Knife

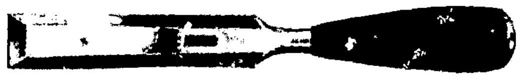
The hacking knife is used to take hard putty off sash (Fig. E-22). The hacking knife has a wedge-shaped, square-ended blade about 4 or 5 in. long made of

hard steel. Many glaziers make their own hacking knives out of tempered steel to ensure lightness, durability, and a cutting edge that will remain sharp.



Glaziers' chisel

Cold chisel



Wood chisel

Fig. E-21. Chisels

Screwdrivers

A glazier needs many sizes of both straight-blade and Phillips screwdrivers in his work. These can be purchased with either wooden or plastic handles; the plastic handle is generally more satisfactory as it is more durable. A workman should never hammer on a screwdriver and should never use it for prying.

The automatic ratchet screwdriver is one of the greatest time- and energy-saving hand tools that the glazier can own (Fig. E-23). It can be used on most glazing jobs, but it is most useful on store front and metal work that involves the installation or removal of many screws. The tool can be set for left-hand or right-hand ratcheting as well as for conventional rigid operation. When an automatic ratchet screwdriver is used in glazing, the spring return should be taken out of the handle so that the spindle will not tend to fly out and break glass. The tool should be kept well oiled, and it should be kept in the closed position when not in use. It should never be hammered on or used for prying; if the shaft is bent, the tool will not work properly.

Fig. E-22. Hacking knife

Fig. E-23. Automatic ratchet screwdriver

Glass Pliers

Two types of pliers for breaking glass are preferred by glaziers: these are the flare-grip-jaw pliers and the drop-jaw pliers, which are very similar. Two other types of glass pliers, both having offset jaws, are used by glaziers; one type is spring operated, and the other is manual. The latter types are designed for store front work and for use in tight places. These four types of glass pliers are used for 1/2-in. and thinner glass, and range in length from 6 in. to 10 in. (Fig. E-24). Glass pliers up to 15 in. in length and weighing as much as 5 lb. are available for use on glass that is more than 1/2-in. thick.

Glass pliers should never be used for anything but glass. If the jaws of the pliers are badly marred or out of alignment, they will not grip the glass correctly, and a poor break will result.

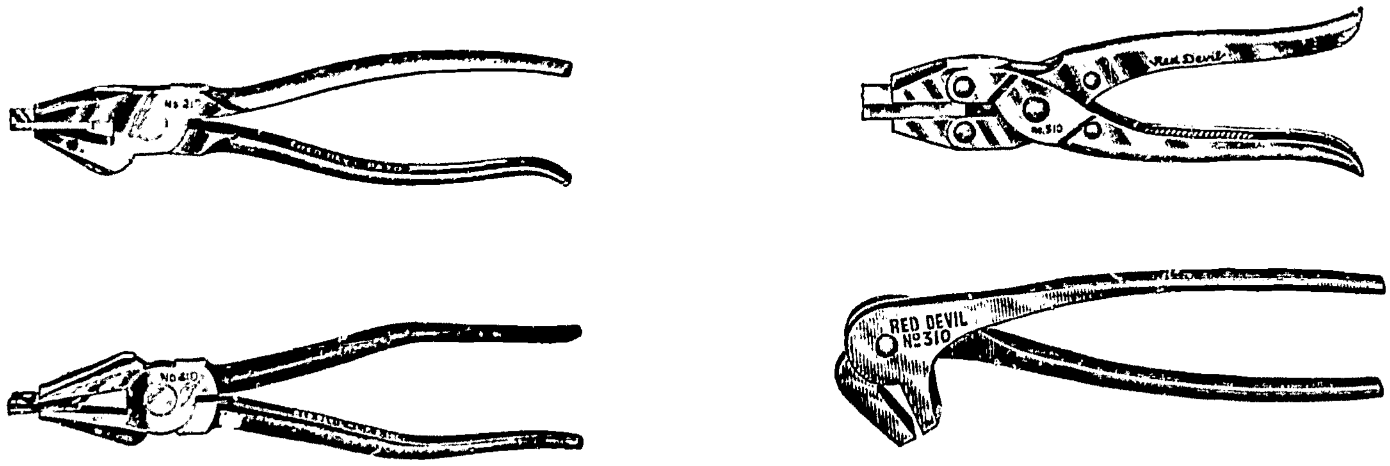


Fig. E-24. Glass pliers

The Glass Breaker

The glass breaker, which was designed for on-the-job use, is a tool that can save the glazier a great deal of work (Fig. E-25). There are several types of glass breakers, most of which are made of an aluminum alloy. Glass breakers find their greatest use when cutting is necessary after the glass is in place. If they are to work properly, they must be kept from becoming badly marred or bent.

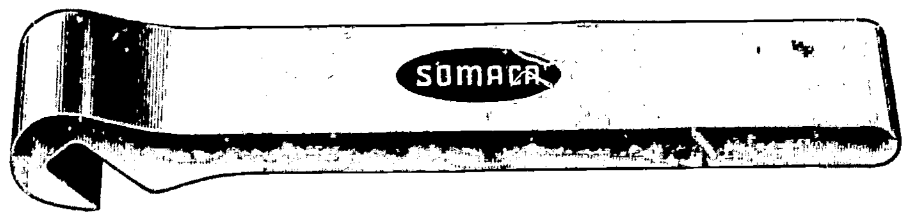


Fig. E-25. Glass breaker

The Plate Glass Lifter

The plate glass lifter is used for lifting one end of a plate for blocking (Fig. E-26). It can be useful when block adjusting is necessary on flush glazing. The glazier must be careful to place the lifter squarely under the edge of the plate if he is to avoid chipping or breaking the glass.

Glass Tongs

Glass tongs are used to pull large plate glass from slot storage racks in the glass shop. They are made of forged steel and have large rubber-lined jaws that grip the glass (Fig. E-27). One handle is hooked to prevent the glazier from losing his balance if his hands slip. When the jaws of the tongs are forced into the slot rack to grip a plate, care should be used to avoid chipping the edges of the plate glass in the adjoining slots.

Straps and Slings

Straps and slings are used for carrying glass that is too large for two men to carry. A typical sling is made of leather or heavy canvas webbing with a

handle on each end; a rubber pad in the middle of the sling cushions the glass. Sometimes a simple leather strap of appropriate length, usually about 2 in. wide and 1/8 in. thick, is used as an aid in carrying large lights of glass; such a strap is often used in setting large glass in place. A workman at each end grips the strap by wrapping it around his hand.

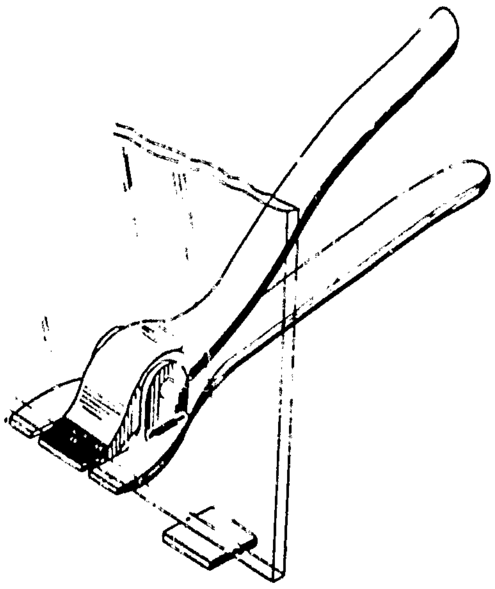


Fig. E-26. Plate glass lifter

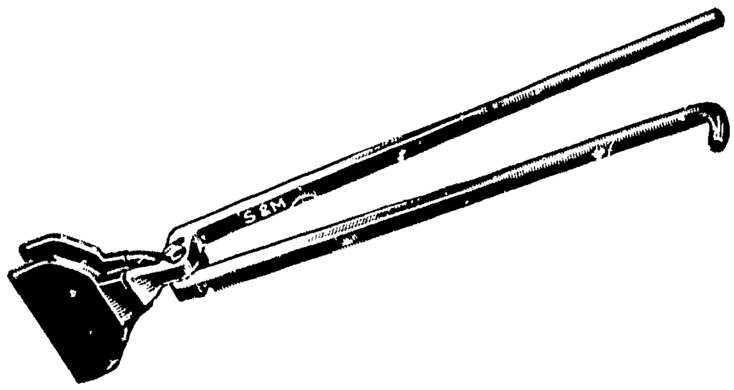


Fig. E-27. Glass tongs

A novel type of sling--the "third man" sling--is made of padded wood or aluminum and has a handle on one end and a padded hook on the other. This type of sling, which is about two feet long, is very useful when two men are handling wet glass or when an extra man lifts the middle of the glass.

Vacuum-Cup Glass Holders

The vacuum-cup or suction-cup glass holder is one of the most useful safety tools available. It can be used to good advantage in most glazing jobs--construction, replacement work, or shop work--where flat glass must be handled safely and efficiently. A typical vacuum-cup glass holder is manufactured with one, two, or three vacuum grips (Fig. E-28). A good vacuum cup is capable of holding more weight than a man can lift. The rubber part of any vacuum-type glass holder must be protected at all times against scratches, gouges, cuts, or mars, and the tool should not be used if there is evidence that the rubber is rotting. The tool must be kept in its storage box when not in use and must be kept clean. The glass surface to which it is to be applied must also be kept clean.

A recently developed heavy-duty vacuum-type glass holder is shown in Fig. E-29. This holder is similar in principle to the large power-operated vacuum-cup holders that are now used in conjunction with power lifts or telescopic booms in the handling of large plate glass in factories or in jobs such as the glazing of high-rise buildings. The heavy-duty holder shown has an 8-in. flat gripping pad and, like the power-operated holder, is designed for lifting heavy glass. It develops about 1/4-ton attaching pressure by means of a built-in, hand-operated vacuum pump that also provides a safety feature. The free-floating pump plunger serves as an indicator that gives warning of any leakage, and consequently of any reduction of gripping force; thumb operation of the pump

plunger restores full holding power in this event. Grooves on the face of the flat gripping pad equalize pressure and eliminate distorting forces. Operation of a release valve on the body of the tool completely releases the grip.

Fig. E-28. One-, two-, and three-grip vacuum-cup glass holders

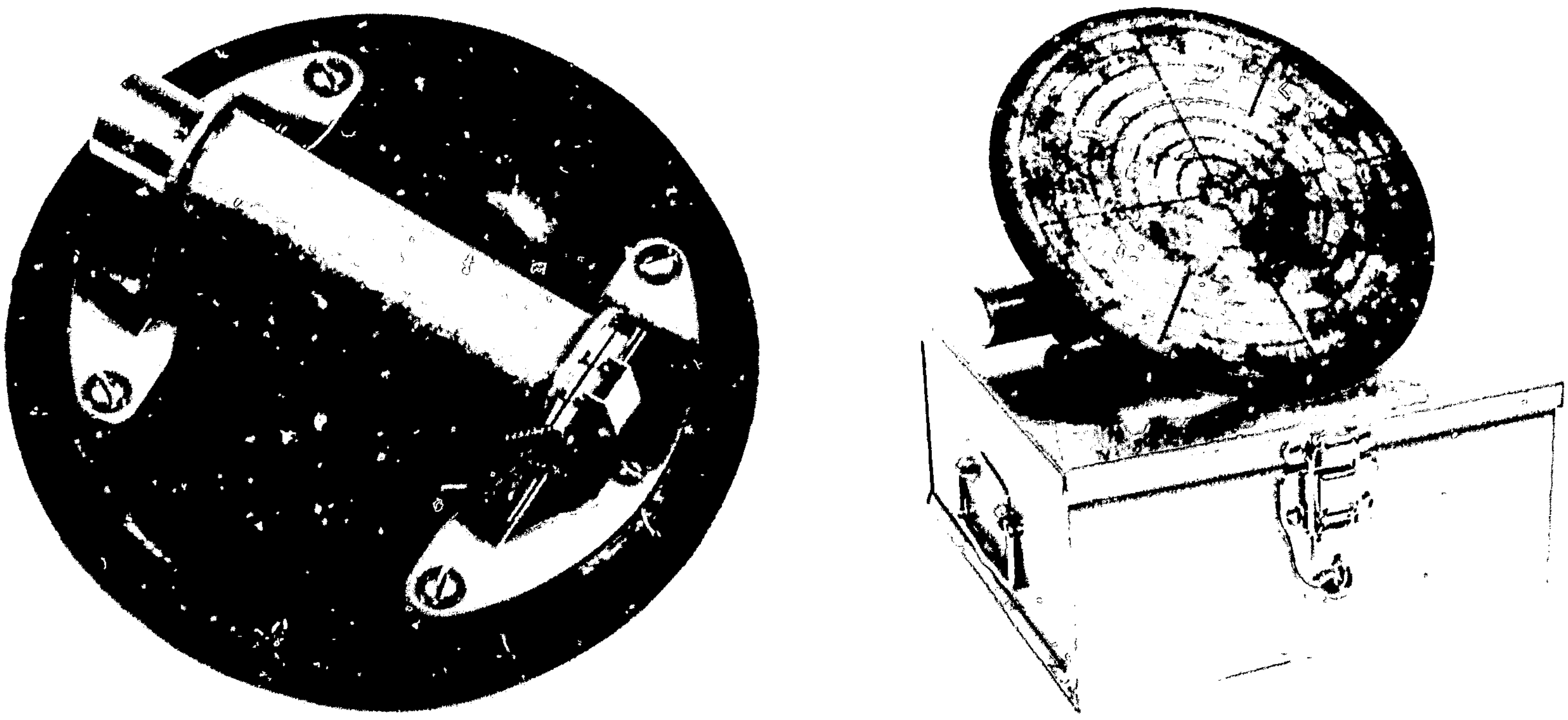


Fig. E-29. Heavy-duty vacuum-type glass holder

The Rubber Hand Grip

The rubber hand grip used by the glazier is invaluable for carrying glass. It is made of any soft pliable rubber and is about 7 in. square. Rubber hand grips not only protect the hands against cuts but also give the glazier a better grip on large lights of glass. The rubber hand grip should be kept clean at all times, and its surface should be kept rough.

The Glass Dolly

Glass dollies are designed to help the glazier handle and move glass safely and easily. A typical unit is made of a length of hardwood with a padded groove

down the center for holding the glass. Two 6-in. diameter wheels with solid-rubber tires are mounted at the center of the dolly, and a smaller swivel-type roller is mounted on each end. These smaller rollers do not touch the ground unless the dolly tips.

When he is using a glass dolly, the glazier should practice the good safety rule of being prepared at all times to lift the plate in case the dolly should turn over, and he should always be sure that the glass is carried as close as possible to the balance point of the dolly.

Caulking Guns

Caulking guns for use in glazing are of either the full-barrel or the half-barrel type (Fig. E-30). The full-barrel gun incorporates a cylinder that can be loaded with either bulk caulking or a special cartridge; a hand trigger forces a plunger down the cylinder, and the plunger forces the caulking material out of the nozzle. The caulking for the half-barrel gun is purchased in a cardboard cartridge that is equipped with a soft plastic nozzle. The cartridge is inserted in the top side of the barrel. Like the full-barrel gun, the half-barrel gun (or "cradle" caulker) has a hand trigger and plunger for forcing out the caulking material.

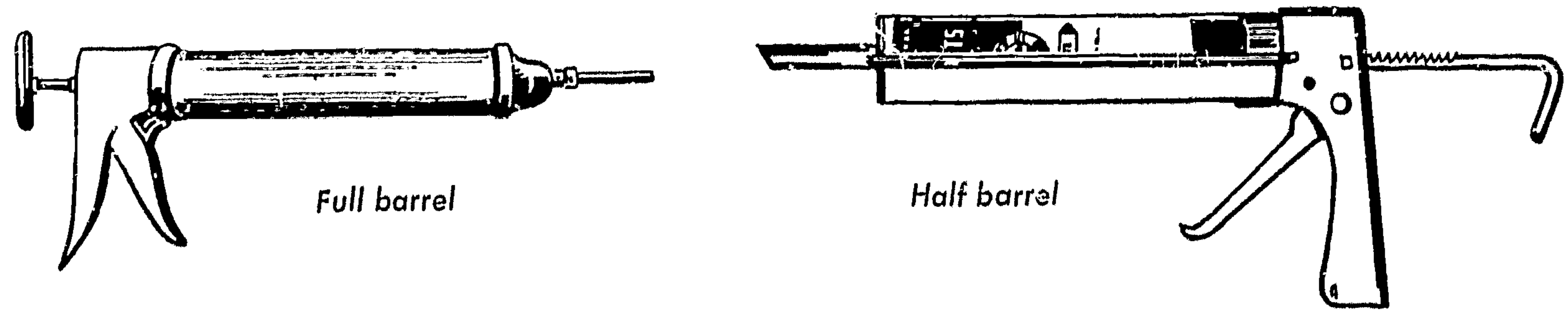


Fig. E-30. Caulking guns

Saws Used in Glazing Work

A variety of common types of saws--hacksaws, handsaws, backsaws, and keyhole saws--are used in glazing work.

The hacksaw. A hacksaw selected for the glazier's tool chest should be of quality construction and have a strong frame and handle to ensure the straight cutting of metal. Dropping the tool may break the plastic handle and may spring the frame, reducing the span between the blade-attachment pins and making adequate tightening of the blade impossible.

The handsaw. A crosscut saw with eight teeth to the inch is a good general-purpose handsaw that is useful in glazing work for cutting such items as mirror backs, wood stops, plywood sheets, and the like. The handsaw should be kept sharp, true, and free of rust. It is a good rule never to lay a saw on its side. It should be hung up or put in a saw rack when not in use; this will protect the set and sharpness of the teeth and keep the saw from being accidentally bent.

The backsaw. The backsaw, which is smaller than the handsaw and is rigidly reinforced along the back of the blade, is used only for cutting miters of butt ends on wood stops. The reinforcement of the blade keeps it straight for accurate cutting.

The keyhole saw. The keyhole saw is useful for cutting inside holes in wood. The blade is long and tapered so that it can be started in a very small hole, and in some saws of this type is replaceable. Never force a keyhole saw; the thin, tempered blade is easily bent or broken.

The Metal-Cutting Miter Box

The metal-cutting miter box is used in conjunction with a hacksaw in glazing work to cut metal trim, metal sash, or any metal that can be cut with the hacksaw. The miter box incorporates an adjustable frame that guides the hacksaw to ensure accurate cutting of the selected angle. The device is equipped with screw clamps for securing the piece to be cut, and has a replaceable wooden cutting base. The miter box should be kept assembled and equipped with a saw if the shop does a great deal of metal miter cutting. A metal cutting miter box is shown in Fig. E-31.

Miscellaneous Hand Tools and Equipment

The glazier uses a number of small hand tools and related articles in addition to the items that have been discussed so far in this topic; included among these are pocket knives, nail sets, wrenches, and respirators.

The pocket knife. The pocket knife has many uses in glazing, but in no case should it ever be hammered on or used for prying. The glazier should choose a knife with two or three high-grade steel blades, each about 3 in. long.

The nail set. The nail set is used in glazing work to countersink the heads of finishing nails and casing nails. Nail sets are usually 4 in. long, and have pointed or cupped tips ranging in diameter from 1/32 in. to 5/32 in. The body of the tool is knurled.

The hexagonal nut wrench. The hexagonal nut wrench, in sizes from 1/4 in. to 9/16 in., is used in certain glazing operations. The 5/16 in. wrench is used in many store-front jobs for tightening the nuts that secure the metal division bars.

The respirator. Whenever a glazier must work in an area where he will be exposed to such unhealthful dust as that produced from silica or cement, he should wear a respirator (Fig. E-32). Special cotton pads ("facelets") in the cannisters of the mask filter most of the dust from the air the worker breathes. The mask is made of soft rubber to fit the contours of the face and is held on by an elastic band.

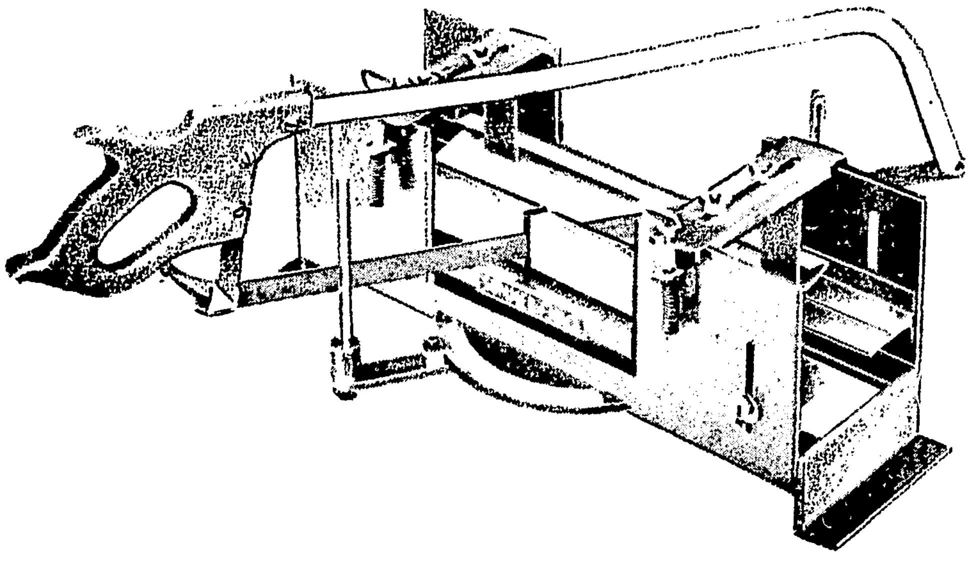


Fig. E-31. Metal-cutting miter box

Fig. E-32. Respirator

Study Assignment

Examine manufacturers' catalogs and other sales literature describing hand tools and related equipment used in the glazing trade. This material will be found in your classroom library.

UNIT E--TOOLS AND EQUIPMENT

TOPIC 3--HAND TOOLS AND EQUIPMENT - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The most economical hand tool is not necessarily the least __1__ one.	1. ________
2. If a hand tool has polished steel surfaces, these should be wiped occasionally with a(n) __2__ __3__.	2. ________ 3. ________
3. A bent-blade putty knife is especially useful for running putty in __4__ sash.	4. ________
4. A screwdriver with a __5__ handle is likely to be more durable than one with a __6__ handle.	5. ________ 6. ________
5. The point-driving hammer should never be used as a __7__ __8__ hammer.	7. ________ 8. ________
6. The head of chisel becomes dangerous if it is permitted to __9__.	9. ________
7. The vacuum-type glass holder that has an 8-in. gripping pad can develop an attaching force of about __10__.	10. ________
8. The __11__ __12__ jaw and __13__ jaw types of glass pliers are preferred by most glaziers.	11. ________ 12. ________ 13. ________
9. Rubber hand grips should be kept __14__ at all times, and their surfaces should be kept __15__.	14. ________ 15. ________
10. A putty knife should never be used as a __16__.	16. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The plate-glass lifter is used for lifting a corner of a plate for blocking.	1.	T	F
2. No attempt should ever be made to disassemble an automatic ratchet screwdriver.	2.	T	F
3. Glass pliers can be used for pulling nails from places that cannot easily be reached with a claw hammer.	3.	T	F
4. A wood chisel can be used for moderate prying.	4.	T	F
5. The "third man" sling is useful in handling wet glass.	5.	T	F
6. A nail set may have a pointed tip.	6.	T	F
7. The hacking knife is the appropriate tool for removing hardened putty from sash.	7.	T	F
8. A glazier's chisel should never be used with a hammer.	8.	T	F
9. The metal-cutting miter box is used with a backsaw.	9.	T	F
10. Vacuum-type glass holders can hold heavier loads than a man can lift.	10.	T	F

UNIT E--TOOLS AND EQUIPMENT

TOPIC 4--POWER TOOLS AND MACHINES

This topic, "Power Tools and Machines," is planned to help you find answers to the following questions:

- What portable power tools are commonly used in glazing work?
- What power machines are employed in the various fabrication and finishing operations of glazing?
- How are power tools and machines used and maintained?

Power tools and machines play an important role in glazing. They are great time savers, and they enable the glazier who can use them properly to work with less effort and greater efficiency. They are fast, dependable, and useful in many jobs, and they are therefore standard equipment for most glass shops.

Although the glazier does not have to purchase the power tools needed for the job--they are always furnished by the employer--he should remember that they are expensive items that are costly to repair or replace, and he should use them carefully and ensure that they are properly maintained. Portable power tools are easily damaged by dropping: cast housings crack, handles and controls bend or break, shafts and other external moving parts bend or become misaligned, and power cords are pulled loose. A power tool or machine that is in heavy and continual use must be lubricated more often than one that is subject to only light, intermittent duty. By the time a power tool gives evidence of inadequate lubrication--an overheated bearing or a howling gear drive, for example--the costly damage has been done. The manufacturer's instruction chart should be followed to ensure that the correct lubricant, in the proper amount, is used for each moving part of the tool.

A power tool must be operated only at the voltage specified on the rating label, and it should not be overloaded or allowed to overheat. A portable power tool should never be picked up or carried by the cord; this weakens and often breaks the wires or their terminal connections, including the internal ground connection. All electrical tools and machines must be properly grounded to minimize shock hazard.

Extension cords of any reasonable length may be used with portable power tools, but they should be the 3-conductor grounding type described in Unit A of this course, and they must be of at least 12 or 14 gauge wire if they are to carry the heavy currents required by most such tools. It should be kept in mind also that the longer the cord, the less power delivered to the tool.

Every apprentice glazier should become thoroughly familiar with the standard safe working practices for the use of power tools and machinery, and he should

observe these practices faithfully to ensure his own safety and that of his fellow workers. Instructions for the safe use and proper maintenance of power tools and machines are given in the discussions of specific items of equipment that follow.

The Portable Electric Drill

The portable electric drill is the most widely useful of all power tools to the glazier. Portable electric drills are available in various sizes and speeds, but the 1/4-in. electric drill is satisfactory for most glazing jobs; it has sufficient power for drilling aluminum and other light metals and wood, and can be used for making small holes in concrete or steel. When much drilling is to be done in concrete, steel, or other hard materials, a 3/8-in. or a 1/2-in. electric drill should be used. No attempt should be made to use a high-speed electric drill for drilling glass. Special low-speed units are employed for this work. The tools employed for drilling glass are discussed later in this topic.

Several precautions should be observed in using an electric drill. Like other motor-driven tools, it should never be overloaded or allowed to overheat. Never force the tool hard enough to slow down the motor. When the drill is in use, the bit should always be pointed away from the operator's body. When an electric drill is not in use, it should be stored in its own case and kept dry and free of dust.

The Portable Electric Hammer

Portable electric hammers are used for drilling, cutting, and chipping in concrete and masonry and for removing old putty from steel sash in reglazing work (Fig. E-33). These tools are particularly useful for jobs on which a great deal of steel sash reglazing is to be done. A light hammer is recommended for chipping out putty and a heavier type for digging out floor hinges in concrete. Tool bits of various sizes are used, depending upon the type of work to be done.

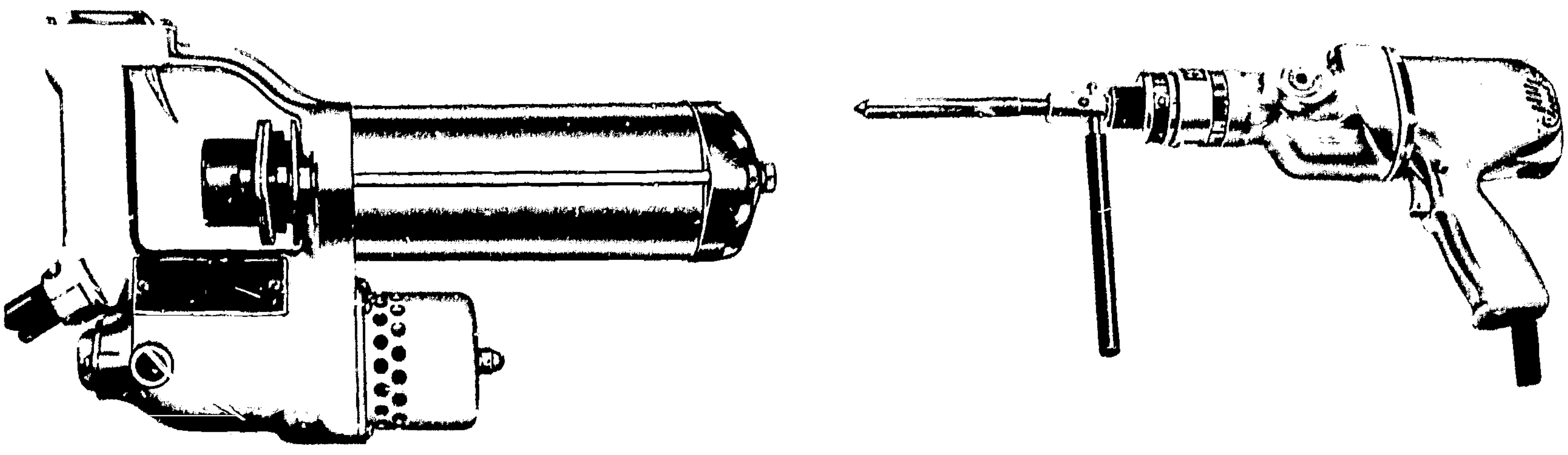


Fig. E-33. Electric hammers

When the glazier uses an electric hammer for removing putty, he must be careful to ensure that the vibrations of the hammer do not break other glass

in the same frame. Tool bits must be kept sharp. The trigger should never be pressed unless the bit is held against something solid; otherwise, the tool bit might come loose and cause an injury.

The Portable Electric Belt Sander

The portable electric belt sander is almost a necessity in the glazing trade because of its versatility (Fig. E-34). It is used for grinding, roughing, and smoothing and for edgework on lights that are too big to be held over a glass edger. Portable sanders can be fitted with sander belts of various grits or with cork-faced polishing belts.

The sander belt is driven by a powerful motor, and it can quickly cause damage to finished surfaces or painful injury if it is not kept under control. Hold the sander firmly, and direct it carefully on the work. Never turn on the sander while the belt is being changed or when the sander is in an upright position on the cutting table. The abrasive surface should always be held away from the body or from clothing. When a sander is in continuous use, lubrication should be checked several times a day.

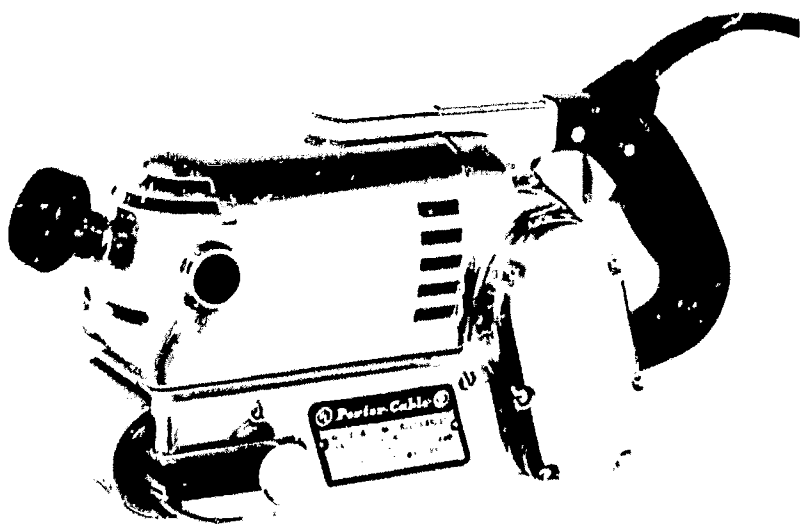


Fig. E-34. Portable electric belt sander

The Wet Abrasive Belt Sander

The wet belt sander is used for grinding, roughing, smoothing, or polishing edges of glass. Various sizes and types of wet belt sanders are available, all of which work on the same principle; that is, they consist of one or more vertical sandpaper belts each operating on two rollers. The belts are available in different grits, ranging from 40 to 400 grit. A double machine is shown in Fig. E-35.

A thin spray of water is directed on the belts to keep the glass from burning, chipping, or breaking. While operating a belt machine, the glazier should be careful that neither his hands nor any other part of his body contacts the faces of the abrasive belts. In grinding a small piece of glass, it is safer to use the flat plate rest than the rollers and glass rest platen. In trying to hold a small piece of glass on the rollers and platen, the glazier may get caught by the belt

or have his hand pulled into the small area between the face of the belt and the glass rest.

The life of a grinding belt will be extended if the mechanic avoids running the sharp corners of the glass into its face; this practice tends to cut holes in the belt and shred it off the machine.

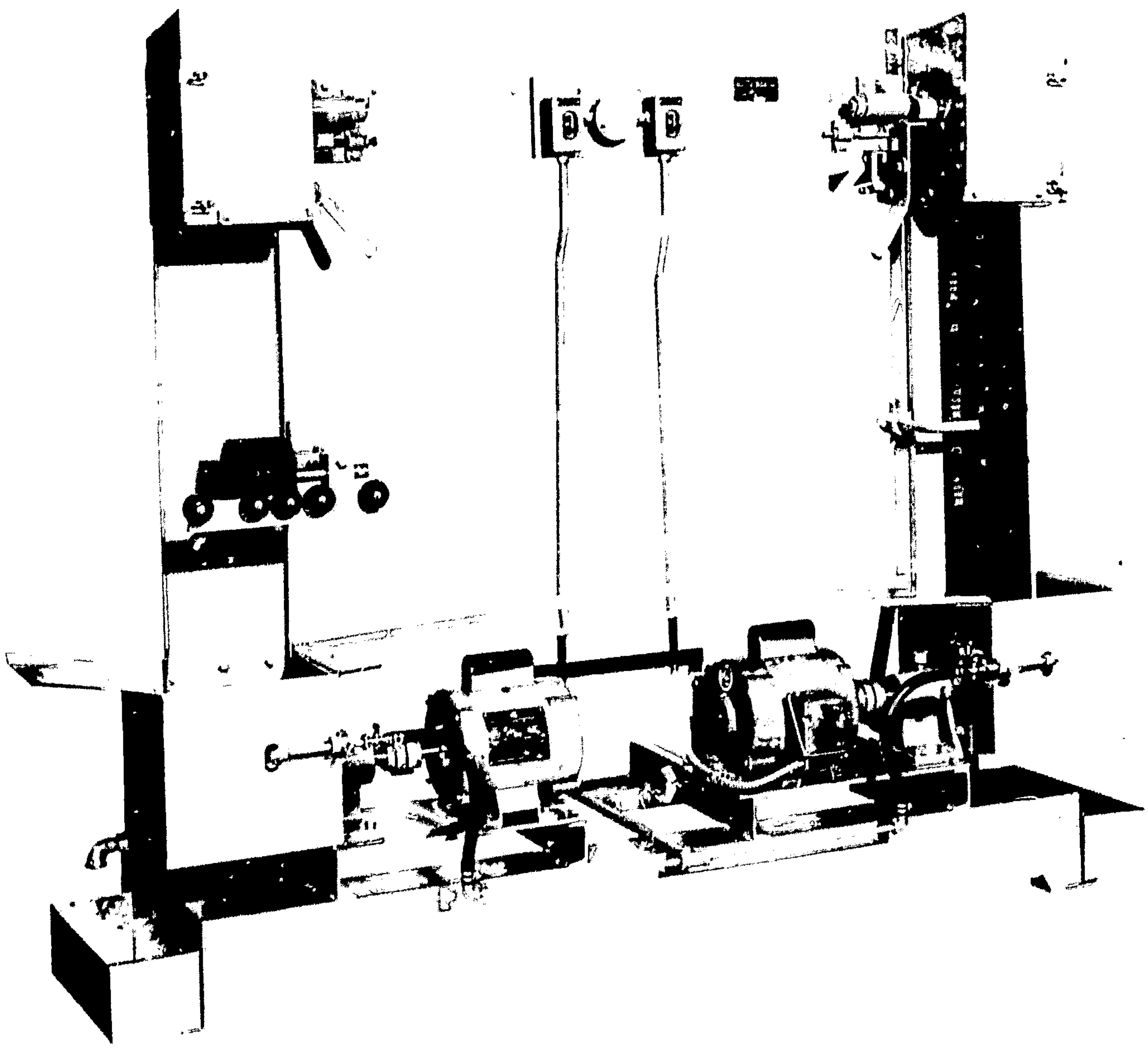


Fig. E-35. Double wet abrasive belt sander

The Electric Rougher

The electric rougher, essentially a large, flat, cast-iron, motor-driven wheel mounted in a tray enclosure on a rigid base, is used for grinding the edges of glass and for making bevels and miters rapidly and economically (Fig. E-36). Above the roughing wheel is a tray from which abrasive grain (crystolon or carborundum) is washed onto the rougher wheel as it rotates. The glazier must be sure to use the right amount of grain and water on the rougher to avoid breaking the glass. Since the rougher has ball bearings and since water is used around its working parts, it is especially important that lubrication be given regular and thorough attention.

Electric Smoother

The electric smoother, which is similar in appearance and construction to the rougher, consists basically of a large circular stone set horizontally over a steel frame (Fig. E-37). The smoother wheel, which is made of Alundum-Aloxite, is used for smoothing ground edges, bevels, and miters. When a ground edge is to be smoothed, it is run over the revolving stone at the same angle at which it was ground. An even stream of water should be directed on the stone when it is in use. The face and edge of the smoother wheel are kept true by means of a barring-off stand.

The Electric Scratch-Wheel Polisher

The scratch-wheel polisher is used for removing scratches on glass surfaces and for polishing bevels and edges (Fig. E-38). The typical scratch wheel consists of a 24-in. cast-iron wheel around which a wooden rim 2 in. thick is fitted. A 3-in. thick and 3-in. wide layer of fine wool felt, made from strong fiber that has been combed and cleaned thoroughly, surrounds the wooden rim. The overall diameter of the wheel is thus 34 in. Cork is used in place of wool felt on some scratch wheels. The motor and wheel are held by a heavy cast-iron frame in a rigid unit that assures true and smooth operation. The felt is dampened with water, generally from an automatic water feeder, and rouge is added automatically to the felt from sticks or bars. When a glazier is holding glass over the wheel, he should be careful not to let the felt catch an edge and pull the glass out of his hands.

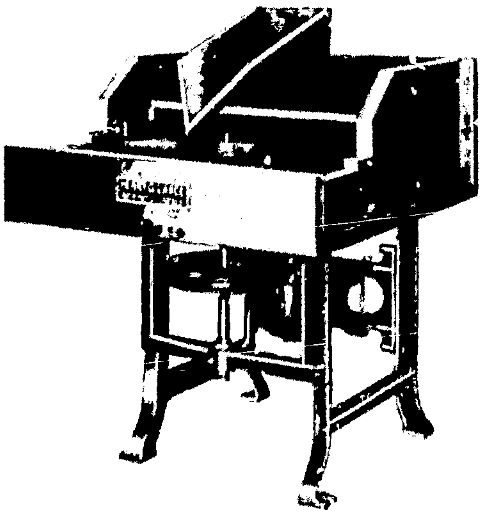


Fig. E-36. Rougher

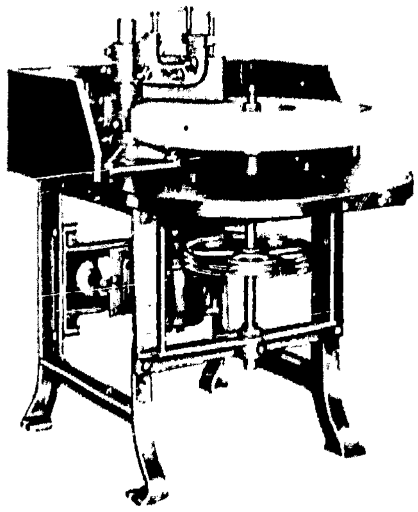


Fig. E-37. Smoother

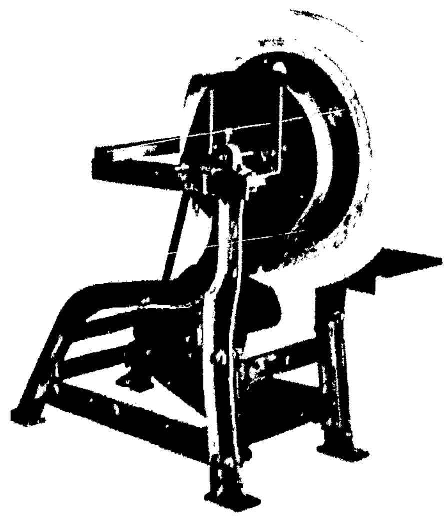


Fig. E-38. Scratch-wheel polisher

Glass-drilling Machines

A glazier's work may involve the use of both stationary and portable machines designed for drilling holes in glass (Figs. E-39, E-40). The spindles of electric drilling machines for glass usually operate at a slow speed, sometimes as low as 130 rpm. The larger glass drills may be adjusted to different speeds for different types of work. The surface of the drill press table should be kept

free from mars or deep cuts; an uneven surface results in uneven pressure on the glass being drilled and consequent glass breakage and chipping around the hole.

Safety should always be kept in mind during the operation of any drill press. The revolving chuck or tool can easily catch onto clothing and cause injury. A chuck key should never be left in the chuck after the drill has been tightened in place or removed.

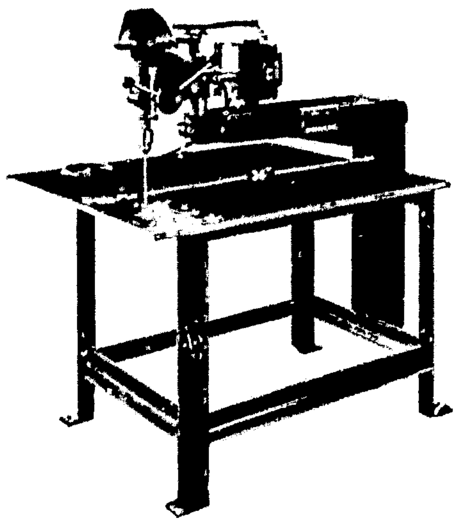


Fig E-39. Stationary glass-drilling machine

Fig. E-40. Portable glass-drilling machine

The Radial Saw

The radial saw is used in glass shops chiefly for metal cutting in the prefabrication of shower doors, bath tub enclosures, sliding glass doors, and aluminum preglaze (Fig. E-41). This tool is a time and effort saver and ensures accuracy on both straight and miter cuts. The radial saw can be equipped with saw blades for either light-gauge steel or aluminum.

Power saws are among the most dangerous power tools if they are not set up and used correctly. Before using the saw, the glazier should check to make sure that the hand guard works properly and that the blade of the saw is tight. The operator of a radial saw should not be interrupted while he is using the machine. When any adjustment must be made on the saw, the power should be turned off. Goggles should be worn while the saw is operated.

Special care should be taken to keep radial saw blades in good condition; they are expensive, and the length of their life depends on how they are used. Avoid jamming metal into the blade; this can cause the blade to twist or warp. Cutting lubricant should be used at all times to lubricate the blade and to keep soft aluminum metal from binding or loading up in the teeth of the saw blades.

The Portable Electric Saw

The portable electric saw is made in various sizes, of which the 6-in. and 8-in. saws are the most common (Fig. E-42). The glazier can use the portable electric saw to cut wood or aluminum. The safety precautions given for the radial saw apply as well to the portable electric saw. Special care should be taken in using any electric saw to make certain that the blade does not bind.

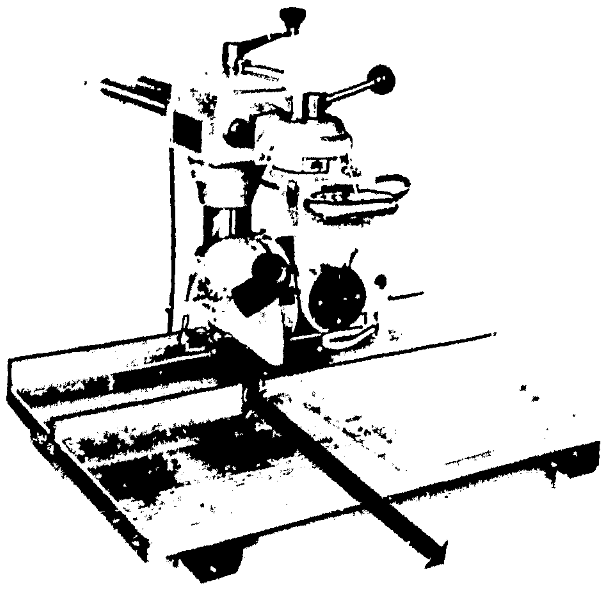


Fig. E-41. Radial saw

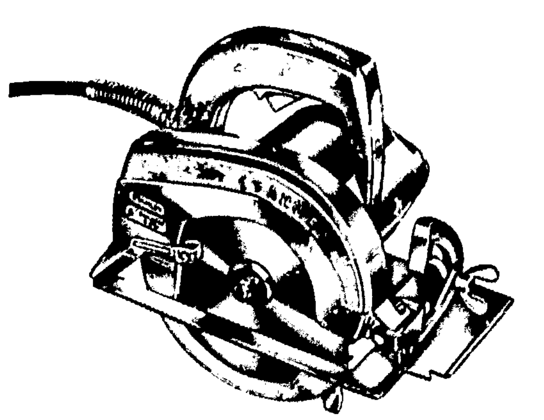


Fig. E-42. Portable electric saw

The Finger-pull Machine

The finger-pull machine is used for cutting finger pulls in sliding glass doors in showcases, information booths, cashiers' cages, and the like (Fig. E-43). It is equipped with an abrasive cutting wheel and a cork polishing wheel. The aloxite cutting wheel, which is typically 1/4 in. to 1/8 in. in diameter and from 1/2 in. to 3/4 in. wide, runs vertically over a large table on which large pieces of glass may be laid. Some finger-pull machines have automatic gauges for controlling the depth of the finger pull. The cutting wheel is counterbalanced so that it will produce only the required amount of pressure on the glass. Water is run on the wheel while the pull is being cut.

Care should be taken to hold the glass firmly in place while the wheel is cutting. The top of the table should be kept clean so that the glass laid on it will not be scratched. The cork wheel should be used with care when a pull is being polished out; if the glass is not held firmly in place and in line with the cork wheel, the edges of the wheel will be cut away by the sharp edge of the pull.

The Notching and Cutoff Machine

The notching and cutoff machine is used by the glazing mechanic to cut notches in lights of glass and in other hard, nonmetallic materials, such as ceramics. It is also used for cutoff work. The typical machine consists basically of a frame, a diamond-impregnated cutting wheel on a shaft, and a powerful electric motor. The wheel, which runs in water, is from 6 in. to 12 in. in diameter and is 0.032 in. or 0.040 in. thick. A portable notching and cutoff machine is shown in Fig. E-44.

In using a notching machine, the mechanic should never crowd the wheel or permit his work to bind up on the wheel. The cut should be kept as cool as possible to cut down work spoilage caused by excessive heat in the corners of the notch, where small invisible runs may branch out from the cut. The machine must be solidly based. Spindle rotation should be true, with no perceptible end play. Plenty of water should be used in the cutting operation.

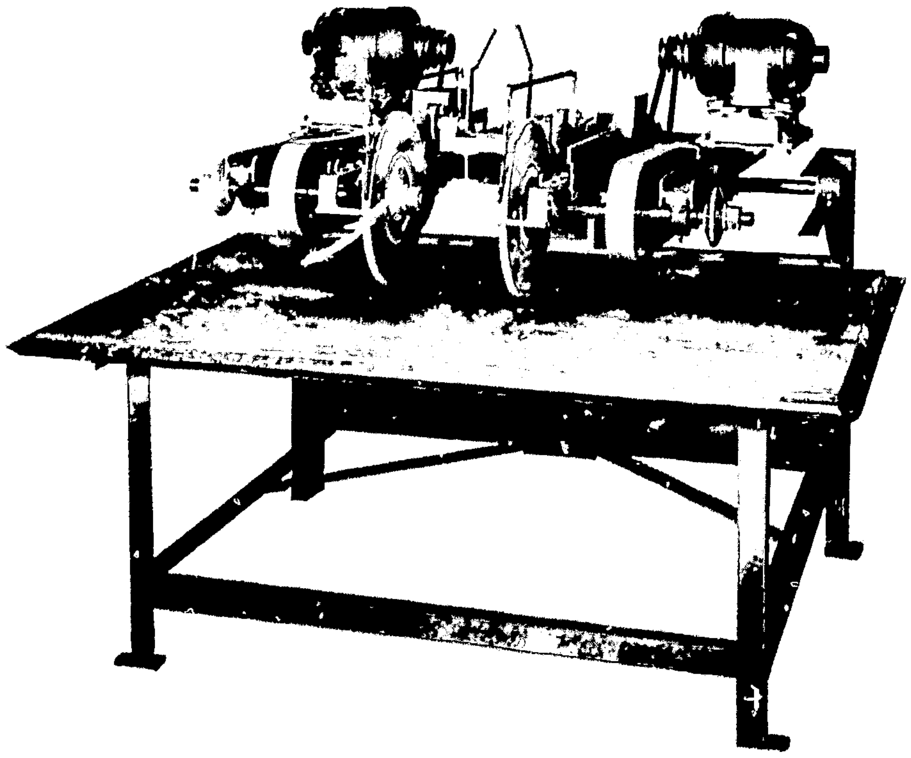


Fig. E-43. Finger-pull machine

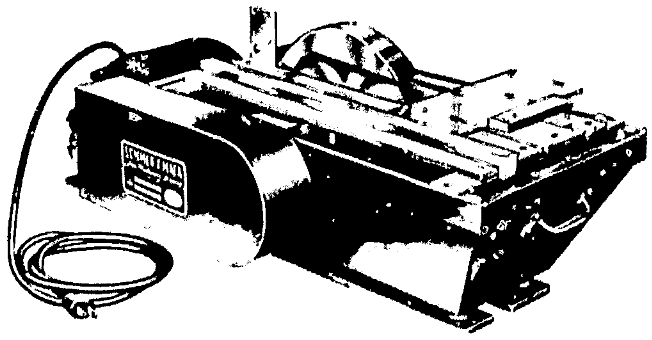


Fig. E-44
Portable notching and cutoff machine

The Glass Edger

The glass edger or upright polishing wheel consists essentially of a steel frame that holds a motor-driven horizontal spindle. One, two, or three carborundum, Alundum, or Aloxite grinding wheels may be mounted on the ends of the spindle (Fig. E-45). A cork wheel for polishing with pumice is sometimes used in place of one of the grinding wheels. The grinding wheel requires water, which is furnished by pans or a pipe system.

The surfaces of the wheels must be dressed with grooves for edging the glass. These grooves are turned in by the factory or by an experienced mechanic who has the dressing tools and the diamond cutting tool needed for their proper cutting. Because continuous use of the wheels causes the grooves to become worn, periodic truing and honing are required to keep the needed pencil edges. A mechanic inexperienced in the proper truing and grooving of the edger wheel can do as much harm to the machine as would be done if a piece of glass were broken during the edging process, chipping out a piece of the wheel.

The mechanic should use a wheel edging machine only for those sizes of glass he feels that he can control correctly. In grinding any glass, the glazier must guard against shrill or sharp vibration, which can break the glass.

The Diamond Wheel Glass Edger

Diamond wheel edgers are high-speed precision machines designed for the edge polishing of safety glass. The diamond wheel turns faster than other edging wheels. The diameters of diamond wheels range from 6 in. to 10 in., whereas the diameter of other edging wheels is typically about 18 in. Water or special coolant must be used with the cutting wheel at all times. A diamond wheel glass edger is shown in Fig. E-46.

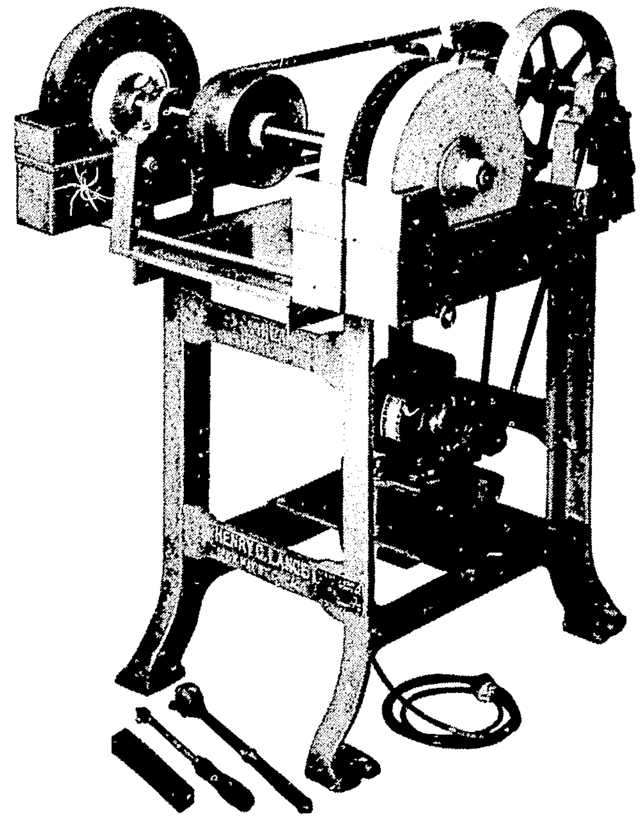


Fig. E-45. Glass edger

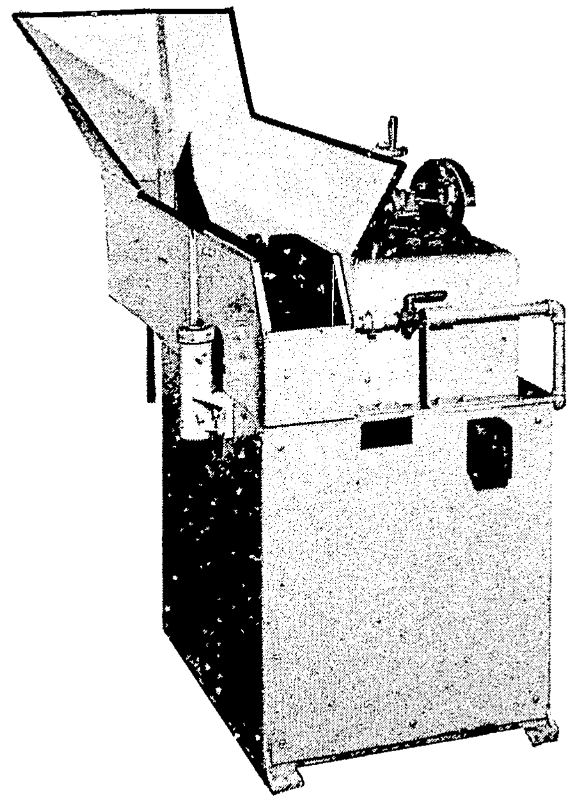


Fig. E-46. Diamond wheel glass edger

Special care should be taken not to try to edge a piece of glass too large to control. Safety glass will not shatter and fly apart when it is edged; plate or sheet glass, on the other hand, can break while being edged in this machine, with possible injury to the operator.

The Electric Putty Softener

The electric putty softener consists of an exposed heating element in a cast asbestos body (Fig. E-47). The tool is designed to direct the heat toward the putty rather than toward the glass. The heating element of the electric putty softener, which operates from the 115-volt power line, becomes red hot in operation, and after a long period of continuous use it may burn out and require replacement. The putty softener should never be left unattended while it is turned on, and the hot tool should never be set on anything that will burn.

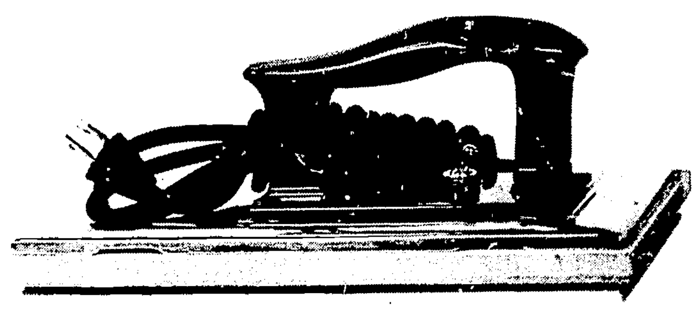


Fig. E-47. Electric putty softener

Study Assignment

Examine manufacturers' catalogs and sales literature describing power tools and machines used in the glazing trade. Such publications will be found in your classroom library.

UNIT E--TOOLS AND EQUIPMENT

TOPIC 4--POWER TOOLS AND MACHINES - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. When an electric drill is in use, the __1__ should always be pointed away from the operator's __2__.	1. ________ 2. ________
2. A __3__ portable electric hammer is useful for chipping out putty.	3. ________
3. When a portable electric belt sander is in continuous use, __4__ should be checked several times a day.	4. ________
4. Portable belt sanders can be fitted with __5__ - __6__ polishing belts.	5. ________ 6. ________
5. The abrasive grain used with the rougher can be either __7__ or __8__.	7. ________ 8. ________
6. The abrasive wheel of the smoother should be used only for __9__.	9. ________
7. The wheel of an electric scratch wheel polisher usually has a __10__ polishing edge.	10. ________
8. The radial saw is used in glazing work chiefly for cutting __11__.	11. ________
9. The cutting wheel of a finger-pull machine is made of __12__.	12. ________
10. The edging of very large lights of glass should be done with a __13__ __14__ __15__.	13. ________ 14. ________ 15. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The electric hammer can be used in reglazing work.	1.	T F
2. The ball bearings of a rougher are lubricated for life at the factory.	2.	T F
3. The 1/2-in. electric drill is suitable for heavy drilling in concrete or steel.	3.	T F
4. The felt rim of the scratch wheel polisher is dampened in use.	4.	T F
5. The portable glass-drilling machine operates at high speed for fast cutting.	5.	T F
6. Water is used on a wet abrasive belt sander to prevent burning and chipping the glass.	6.	T F
7. The portable sander can be used to miter large lights of glass.	7.	T F
8. Some finger-pull machines have depth-control gauges.	8.	T F
9. An extension cord for power tools should include a ground conductor.	9.	T F
10. When a small piece of glass is to be smoothed on a wet belt sanding machine, it is preferable to rest the glass on the flat plate.	10.	T F
11. The wheel of an electric smoother is made of cork.	11.	T F
12. A diamond wheel edger is used primarily for safety glass.	12.	T F
13. Power saws must be equipped with blade guards.	13.	T F
14. The chuck key may be left in the chuck of a drill press after the drill has been removed so that it will be conveniently at hand for the next drilling operation.	14.	T F
15. Power saws are used by the glazier for cutting metal as well as wood.	15.	T F

UNIT E--TOOLS AND EQUIPMENT

TOPIC 5--POWDER-ACTUATED TOOL SYSTEMS

This topic, "Powder-actuated Tool Systems," is planned to help you find answers to the following questions:

- What are the basic components of a powder-actuated tool system?
- What are the basic rules for operating any powder-actuated tool?
- What are the operating techniques that ensure good results with powder-actuated tools?
- What safety rules must be observed in using such tools?

The problems of fastening construction materials to steel, concrete, and other difficult-to-penetrate bases have been greatly simplified by the development of powder-actuated tools. Although these tools have found their widest application in other trades, they are often great time and effort savers in glazing work, as for example in fastening store-front metal or curtain-wall construction.

The dangers that accompany the use of powder-actuated tools were briefly discussed in Unit A. This subject, as well as the proper use and maintenance of powder-actuated tools, will be discussed in detail in this topic.

The Powder-actuated Tool System

The basic components of a powder-actuated tool system are the tool itself, the powder charge, and the fastener. Each will be described in the following paragraphs.

The powder-actuated tool. Powder-actuated tools resemble guns, both in appearance and in principle of operation (Fig. E-48). In the same manner that a pistol fires a bullet, the fastener gun fires a pin- or stud-type fastener down its barrel by means of the force generated from an exploding powder charge. Two methods of driving the fastener are in use: in one, the gases from the exploding charge act directly on the fastener, propelling it with great force; in the other, the gases act on the head of a piston that in turn drives the fastener down the barrel of the gun.

The amount of power required to drive a fastener depends upon the type and thickness of the base material into which it is to be driven. In every case, the operator should use the minimum power that will do the job. In some types of tool systems, the size of the powder charge can be selected to get the power needed for a particular job; in others, provision is made for setting the fastener or piston at variable distances from the charge in the gun barrel to obtain different effective charge strengths from a given cartridge.

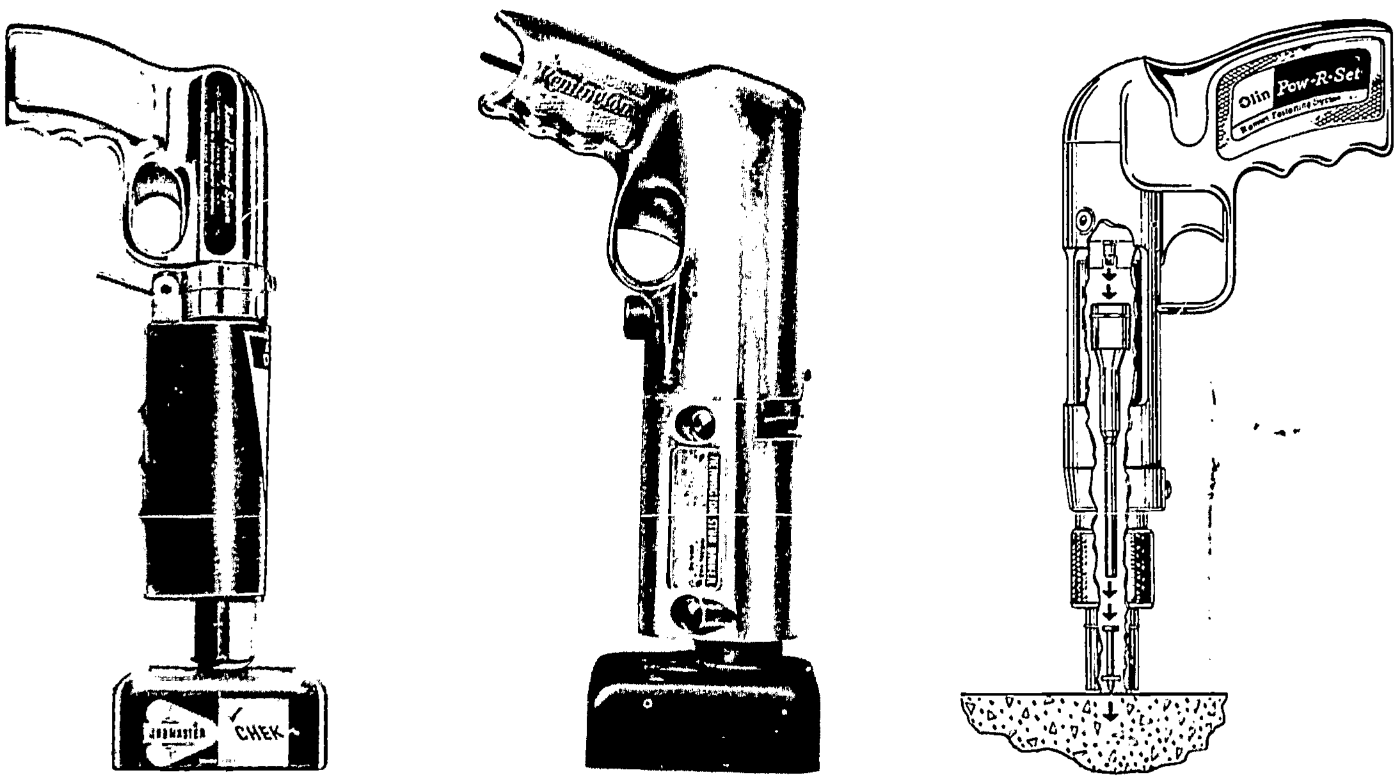


Fig. E-48. Powder-actuated tools

Powder-actuated tools range from about 12 in. to about 16 in. in length. The usefulness of the larger tools is limited to some extent by the difficulty of using them in confined work areas; for example, door bucks and sash may be too small to permit a large gun to operate in corners. Some tools are available with interchangeable barrels to permit operation with fasteners of a wide range of sizes.

Each gun is provided with a safety guard at the muzzle end of the barrel to protect the operator and others in the area against injury from flying material dislodged by the blast or the impact of the fastener. Special guards designed for specific jobs--attaching metal lathing channels or door bucks, for example--are often used with fastener guns to give added protection to the worker and to permit better placement of fasteners.

The powder charge. Powder charges are manufactured for each powder-actuated tool system in accordance with the system design. The caliber of the cartridge varies with the size of the fastener gun; .22, .25, and .38 caliber are the common sizes used. In the tool systems that get variable firing power by using cartridges with powder charges of different strengths, the load strength of the cartridge will be identified by a color code. The State Construction Safety Orders require that a standard color code be employed for the identification of such cartridges. (See the study assignment at the end of this topic.) The color code should be memorized by the worker who is likely to be called upon to use powder-actuated tools. In those systems where the firing power is determined by the distance between the charge and the fastener, the depth of insertion of the fastener in the gun barrel is controlled by means of a calibrated positioning rod.

The fastener. Fasteners of many types, ranging in length from less than 1 in. to about 6 in., are available for use with powder-actuated tools. One common type is a smooth-shanked drive pin that looks and functions like a nail; another

has a threaded stud end that projects from the base material after the fastener has been properly set. (See Figs. E-49 and E-50.) Some types are meant to be used for setting into concrete or masonry only; others are for steel only; and still others can be used for either material.

In some applications, it is inadvisable to drive the fastener directly into the surface material; in such cases, the fastener should be driven through a metal disc, which will provide additional bearing surface between the head of the fastener and the material. Metal discs for this purpose range in diameter from 7/8 in. to 2 in.

Basic Rules for Operating Powder-actuated Tools

The basic rules for the operation of a powder-actuated tools are few and simple, but they all must be observed faithfully if good work is to be done with minimum risk of injury. These rules are as follows:

1. Work safely. Remember that safety must always be the first consideration in the operation of any powder-actuated tool. Follow the safety instructions provided by the manufacturer of the tool system and his authorized representative; know and comply with the regulations for the safe operation of powder-actuated tools given in the Construction Safety Orders; and observe the safety precautions given in this topic of your workbook.

2. Know the material. Know the characteristics of the material that is to be penetrated. To begin with, if a nail can be driven into the base material with a hammer, a powder-actuated tool system should not be used. A powder-actuated tool should never be used if the operator does not know and cannot determine the type or location of the base material (as in the case of a covered floor, for example).

3. Select the correct fastener. The correct fastener must be employed if good results are to be achieved. Use only those fasteners recommended by the tool manufacturer. For concrete, choose a fastener that will penetrate the base material a minimum distance of eight times the diameter of the shank; thus, a light-duty fastener with a 5/32-in. diameter shank must be long enough to penetrate the concrete 1-1/4 in., and a heavy-duty fastener with a 1/4-in. diameter shank must be long enough to penetrate 2 in. A fastener driven into steel must be long enough so that its entire point protrudes through the reverse side of the steel plate.

4. Use minimum power. When selecting a powder charge for driving a fastener or when determining how far to insert the fastener into the barrel to get the desired driving force, always use a relatively weak charge, or set the fastener a fair distance into the gun barrel for the first fastening. It is easier to correct the error of using too little power than to repair the damage (or suffer the injury) that may result from using too much.

5. Know the holding power of the fastener. The holding power of a fastener designed for use with a particular powder-actuated tool system is influenced by a number of factors. Among these are the strength of the powder charge

used or, in systems where this applies, the positioning of the fastener in the gun barrel; the type, strength, and thickness of the base material into which the fastener is to be driven; and the suitability of the fastener for the base material. Consult the tool manufacturer's operating instruction manual for specific information about the holding power of a selected fastener in various base materials.

Spall Control

The term "spall" refers to the chipping or breaking off of concrete at and around the point of entry of the fastener. This defect is caused by the stress that results from the compression of the concrete as the fastener drives in. The tendency to spall is least when the fastener is driven exactly perpendicular to the face of the concrete base material. Also, spall can be greatly reduced or avoided by firing through a steel disc that is from 7/8 in. to 2 in. in diameter; the disc acts as a large washer to hold the concrete in place around the point of entry of the fastener.

Other techniques for reducing or eliminating spall include (1) reducing shock waves and vibration by giving the shanks of long fasteners added support, as by using double driver heads; and (2) using fasteners of relatively small shank diameter, which produce lower stresses when they drive into the concrete.

If the spall is confined to a shallow depth near the surface of the concrete, the strength of the installation will not be seriously reduced. If the fastener penetrates 8 shank diameters into the concrete, the lower 5 diameters provide the holding power; the top 3 diameters are not considered as contributing to holding power, since failure in this region is expected in all cases.

Tips on Good Fastening

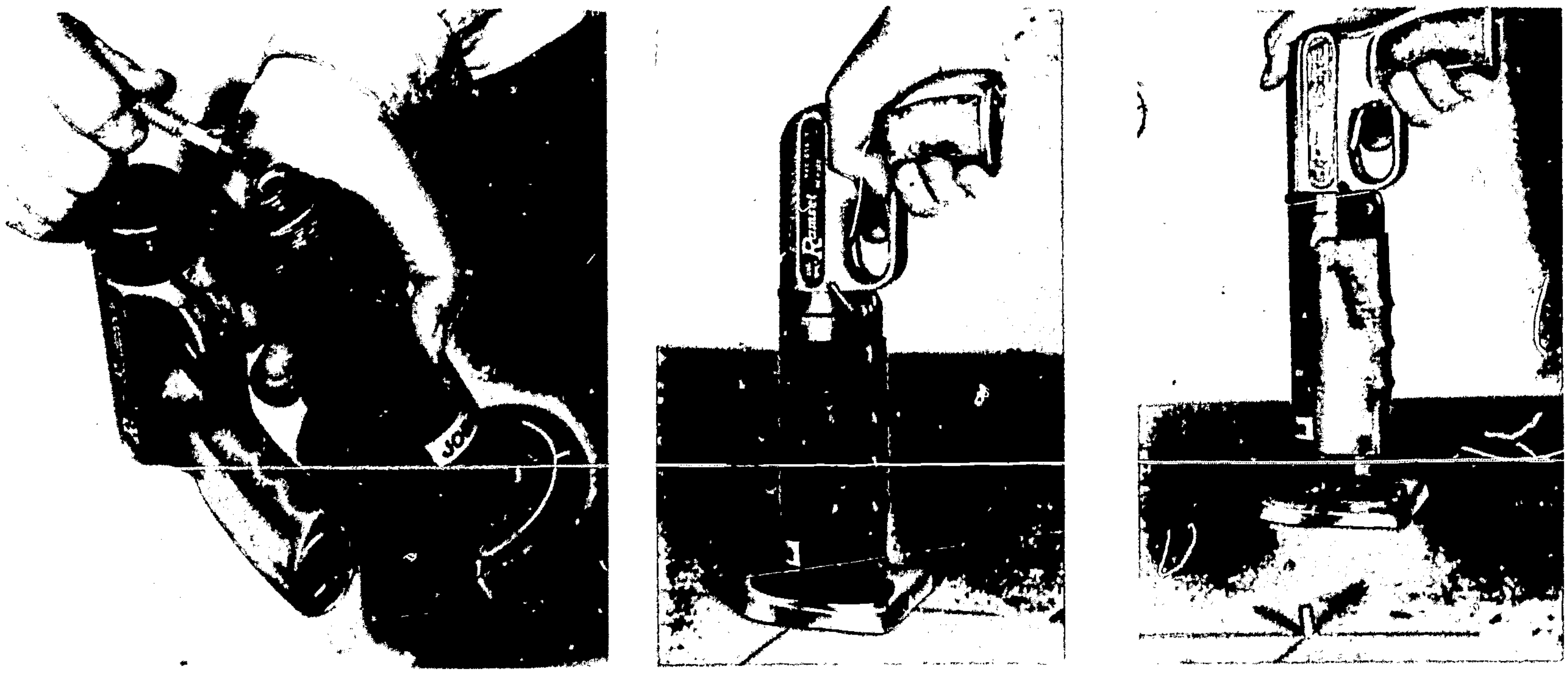
The following suggestions and observations relating to the safe and effective use of powder-actuated tools have been found useful under actual working conditions:

1. When fastening steel to concrete, be especially careful to avoid overpower on fasteners set less than 10 in. apart. Occasionally under these conditions shock waves cause the second fastener to loosen the first.

2. When fastening into relatively hard steel, always fire through a metal disc.

3. A ricochet hazard exists when fasteners are driven into large-aggregate concrete. In such a case, always use the longest possible fastener and see that a substantial portion of the fastener remains in the bore at the time of firing; this engagement tends to prevent the fastener from escaping into free flight if the shank bends or deflects as it strikes aggregate.

4. Never use even a light charge directly for the trial fastening into cement or cinder block; push the fastener at least 2 in. away from the cartridge, or drive through a 7/8-in. steel disc.

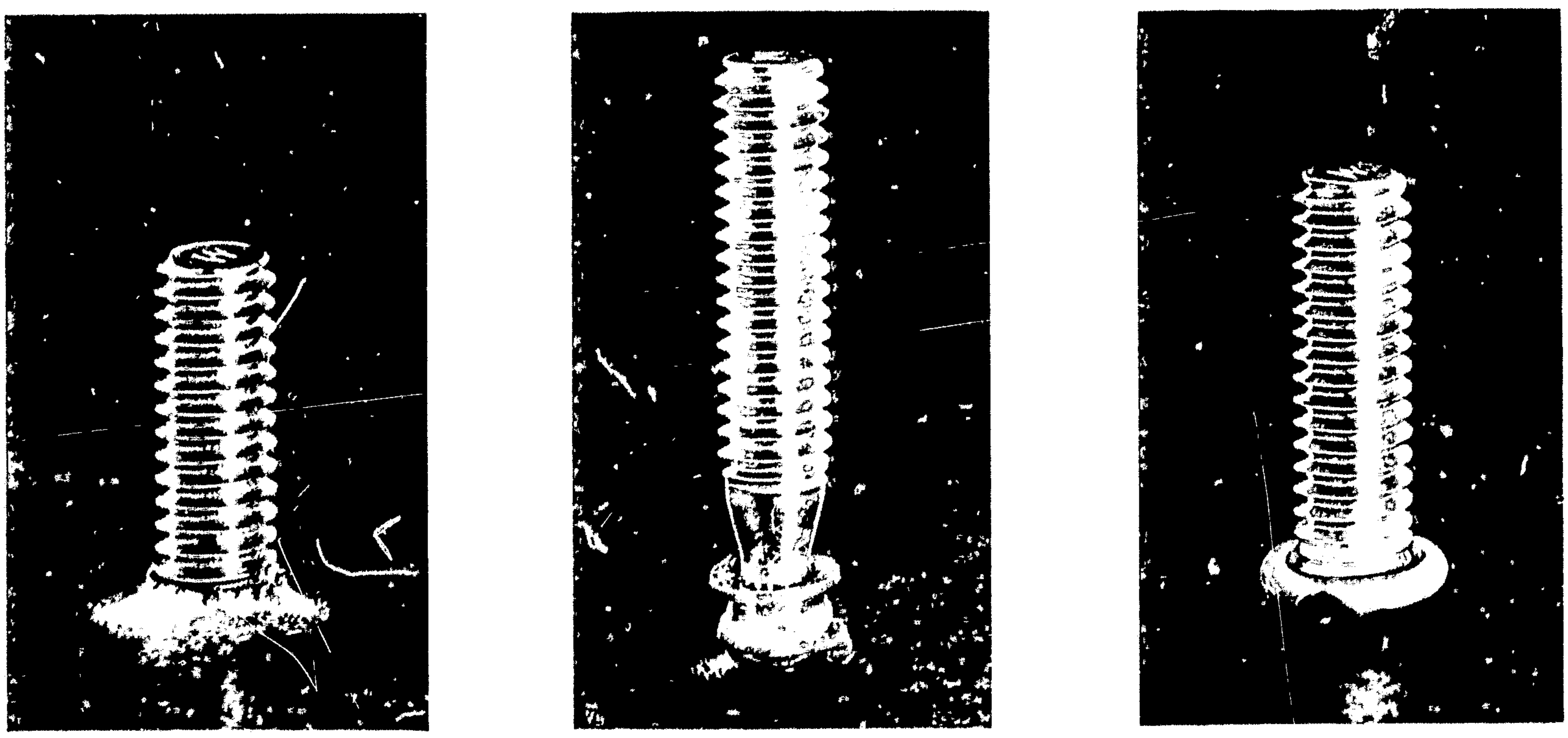


Insert fastener and powder charge, close tool

Hold tool tight against work, depress barrel

Pull trigger—fastener is installed and correctly set

Fig. E-49. Basic steps in fastening with a powder-actuated tool



Charge too heavy

Charge too light

Correct charge

Fig. E-50. Correct and incorrect stud settings

5. When fastening steel to steel, if the fastener must finish flush with the surface of the steel, use a threaded stud and break it off at the threads after firing.

6. When fastening into steel about which you are in doubt, or which you think may be hardened, apply the following test: use a fastener as if it were a center punch; drive it with light hammer blows on the steel. If the tip of the fastener makes indentations in the steel, it will penetrate satisfactorily. If the tip tends to curl and leaves no marks on the steel, DO NOT USE A POWDER-ACTUATED TOOL.

7. When a fastener fishooks, it is an indication that the shank is too long in proportion to its diameter. Use a fastener with a shorter shank, a greater diameter, or both.

8. A stud can be fastened into common brick, but it is more desirable to fasten it into a mortar joint, using a 7/8-in. disc to span the joint.

9. If the fastener must be set into a hard-faced brick, chip the surface of the brick with a chisel first.

10. Powder-actuated tools are effective on terrazzo; fasteners hold very well in this material.

11. Rubber or asphalt tile floor coverings sometimes crack when powder-actuated tools are used on them. Heat the tile slightly with a torch to eliminate this trouble.

12. When fastening wood to a cinder block or a cement block, use a 2-1/2 in. or 3-in. fastener, and use low power. This will leave the fastener head protruding above the wood. Use a hammer to drive the fastener the rest of the way, and the result will be a perfect fastening.

13. A fastener with a knurled shank is required for maximum holding power in steel up to 3/8 in. thick; such a fastener is seldom necessary or even desirable in thicker steel.

14. A smooth-shank fastener set into steel 3/8 in. or more thick can be moved in the pull-out direction if sufficient force is applied; however, it will maintain an approximately uniform holding power over the entire travel of the shank through the steel, or until the point is no longer fully protruding from the steel.

15. If a smooth-shank drive-pin fastener does not penetrate into steel as far as necessary, drive it home with a series of hammer blows. The holding power will not be affected so long as the entire point pierces the steel.

16. A 7/8-in. disc in combination with a utility stud provides the very best method of fastening 2 in. x 4 in. lumber to concrete. The threads control the penetration as they pass through the disc, and variation is never greater than 1/8 in.

17. When fastening steel to uneven concrete, or whenever a gap exists between the steel to be fastened and a base material, assemble two driver heads to a utility stud. Because driver heads are not hardened, the first head will deform as the stud strikes the steel; this deformation causes a pushing action, forcing the steel down tight to the base material. Technically, this has the effect of a gradually applied load instead of an impact load.

18. All studs are very difficult to remove; break them off if necessary by repeated bending back and forth.

19. In cases where a steel member has been welded, set studs as far away from the weld as possible. However, if a fastener must be set close to a weld, fire through a steel disc. This will generally permit successful fastening.

20. The strength of a 1/4-in. stud is approximately equal to that of a 3/8-in. bolt.

The Safe Use of Powder-actuated Tools

Powder-actuated tools make use of the high-pressure gases developed from the confined burning of gunpowder, and they are therefore potentially as dangerous as conventional firearms; however, the development of these tools over the years has made them relatively safe to operate, so long as the prescribed precautions are observed.

Certification of operators. Because safety is the most important consideration in the operation of powder-actuated tools, no person may use them unless he meets the requirements listed in Article 27 of the Construction Safety Orders. (See the study assignment.) In brief, a worker cannot be certified to operate a powder-actuated tool unless he (1) is at least 21 years of age or is in the final 6-month period of his apprenticeship; (2) is able to read English; (3) has been adequately trained in the use and maintenance of the tool; (4) has passed a related written examination; and (5) has demonstrated his competence to use the tool.

Safety precautions. The safe use of powder-actuated tools is absolutely dependent upon the faithful observance of safe working practices. First of all, a glazier should never attempt to operate any powder-actuated tool without reading and understanding the instruction manual for that tool. The manual will describe the components of the tool kit, listing parts and part numbers; explain the loading and firing cycle of the tool, and the use of extensions, jigs, fixtures, and shields; give appropriate maintenance instructions; and give the safety precautions to be observed in using the tool.

All of the safety precautions given in the tool manual, as well as those given in the Construction Safety Orders, are important and must be observed if these tools are to be used without injury to operators or bystanders. Some of the more important rules for the safe operation of powder-actuated tools are the following:

1. NEVER attempt to set a fastener through a previously prepared hole in steel without using an acceptable alignment guide.

2. NEVER fire the tool in half-shield position, unless the work itself provides protection against ricochet.

3. NEVER use a barrel extension unless the safety control rod is accurately set to prevent firing at an angle.

4. NEVER use fasteners, cartridges, or other components that are not specifically made for the powder-actuated tool system.

5. NEVER fire into anything unless you are sure that the fastener will not drive completely through it.

6. NEVER set a fastener less than 3 in. from the edge of concrete or less than 1/2 in. from the edge of steel, unless a special guard, jig, or fixture is used.

7. NEVER use anything but a factory-recommended fixture for any special fastening.

8. NEVER remove a tool from the work surface immediately in the event it does not fire; wait for at least 15 seconds, then remove the powder charge and dispose of it safely, holding the muzzle against the work surface until this operation has been performed.

9. NEVER leave a loaded tool lying about. If you decide not to fire it, unload it.

10. NEVER fire into cast iron, tile, high carbon steel, or other hard or brittle materials.

Study Assignment

1. Construction Safety Orders. Read Article 27.

2. Read catalogs and operator's manuals issued by such manufacturers of powder-actuated tool systems as Ramset and Remington. Such materials will be found in your classroom library.

UNIT E--TOOLS AND EQUIPMENT

TOPIC 5--POWDER-ACTUATED TOOL SYSTEMS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right, in the space that has the same number as the space in the exercise.

1. The most important consideration in the operation of any powder-actuated tool is __1__. — 1. ________

2. The operator of a powder-actuated tool must use only those __2__ recommended by the tool manufacturer. — 2. ________

3. A(n) __3__ sign must be posted in any area where a powder-actuated tool is being used. — 3. ________

4. Each qualified operator of a powder-actuated tool must carry a(n) __4__ __5__. — 4. ________ 5. ________

5. In case of a misfire, the powder charge should not be extracted until at least __6__ seconds have passed. — 6. ________

6. A tool should never be fired in __7__ __8__ position unless the work itself provides protection against ricochet. — 7. ________ 8. ________

7. The penetration of the fastener is controlled in some types of tools by using __9__ __10__ of various strengths and in others by adjusting the distance between the cartridge and the __11__. — 9. ________ 10. ________ 11. ________

8. A(n) __12__ __13__ must be used when setting a fastener through a pre-drilled hole in steel. — 12. ________ 13. ________

9. If a fastener is too long in proportion to its diameter, it will __14__. — 14. ________

10. Fasteners with __15__ shanks should be used to get maximum holding power in steel that is less than 3/8 in. thick. — 15. ________

11. When a fastener is to be driven directly into a mortar joint, a(n) ___16___ ___17___ must be used to span the joint.

16. ____________
17. ____________

12. When ___18___ is to be fastened to a cinder block or a cement block, a steel disc of at least 2-1/2 in. diameter must be used.

18. ____________

13. Short fasteners must never be used in ___19___ ___20___ concrete.

19. ____________
20. ____________

14. No attempt must ever be made to fire a fastener into ___21___ - ___22___ steel or other than ___23___ or ___24___ materials.

21. ____________
22. ____________
23. ____________
24. ____________

15. A powder-actuated tool must never be used in a(n) ___25___ atmosphere.

25. ____________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Cartridges may be stored in the same box with a powder-actuated tool.	1.	T	F
2. All powder-actuated tools must be kept unloaded until just prior to the intended firing.	2.	T	F
3. In the event of a misfire, the muzzle of the tool must immediately be removed from the work surface.	3.	T	F
4. Spall results from the compression of the steel base material by the fastener.	4.	T	F
5. Color coding is used to distinguish the strengths of powder charges in fastener-gun cartridges.	5.	T	F
6. Some fastener guns are available with interchangeable barrels.	6.	T	F
7. Fasteners made from long nails can be used with the smaller powder-actuated tools in an emergency.	7.	T	F
8. A fastener driven into steel must be long enough to allow all of the point to appear through the reverse side of the steel plate.	8.	T	F
9. The first or test firing into a base material should be done with low power.	9.	T	F
10. Firing through a steel disc is an effective means of controlling spall.	10.	T	F
11. The cracking of the floor-covering material that is sometimes encountered when firing through rubber or asphalt tile can be avoided by using relatively weak powder charges.	11.	T	F
12. The strength of a 1/4-in. stud is about equal to that of a 3/8-in. bolt.	12.	T	F
13. Powder-actuated tools are potentially as dangerous as firearms.	13.	T	F
14. A loaded fastener gun may not be left unattended for more than 15 minutes.	14.	T	F
15. Special fasteners are available for setting in high-carbon steel.	15.	T	F

UNIT

F

Materials

TOPIC 1--GLASS AND RELATED GLAZING MATERIALS

This topic, "Glass and Related Glazing Materials," is planned to help you find answers to the following questions:

- What are the qualities of glass?
- How is glass handled to prevent damage?
- How is glass made?
- What different kinds of glass are available?
- What uses are made of the different types of glass?

Glass, in addition to being one of the most durable and beautiful of all man-made products, has many qualities that make it one of the most valuable of all man-made products. The cathedrals that were built in Europe hundreds of years ago are today landmarks of architectural art and are proof that glass is durable and that it has an outstanding quality of beauty. Other sources of such proof are numerous, for many of the very old buildings in the United States have glass that is in good condition and that has retained its original luster. Proof that glass is one of the most valuable of all man-made products is also in evidence everywhere one looks. And the ever-increasing number of different uses being made of glass reveals that its value is far from being fully realized.

Despite the proven durability of glass and its retention of original luster and beauty, glass requires careful handling and appropriate care; for it is subject to damage and may be made unsatisfactory for use by even minor damage to its surface. Certainly, glass is subjected to more detailed visual scrutiny than any other man-made material; for it is most frequently installed so that it is in the line of vision. The human eye, a powerful comparator, quickly detects even the smallest of flaws in the glass. The greatest of care must, therefore, be taken to select for each installation the proper quality of glass and, in making the installation, to handle the glass so that it is not damaged in any way.

Handling glass properly is a responsibility that is shared by the manufacturer, the dealer, the glazing contractor, and the glazier. The manufacturer is primarily responsible for packaging glass correctly for shipping. The dealer is responsible for keeping glass stored correctly and for taking it from storage and delivering it safely to the site where it will be installed. However, most dealers not only sell glass but also contract for the installation of it. In these instances the dealers become the contracting glaziers and hence assume responsibility for correctly storing the glass on the job site and for all phases of safe

handling until the glazing work is completed and the job is accepted by the general contractor. The glazier's responsibility is to know how to handle glass properly, to know the installation requirements, to be skillful in his trade, and to follow the work orders issued by his employer. However, if the glazier finds a work order that would require the use of other than approved glazing procedures, he should confer with the one who issued the order and discuss the problem before he does the required work.

Glaziers and others who share responsibility for handling glass should be informed regarding ways in which glass may be damaged and its value thus reduced. And in addition to having this information, all must know the precautions that should be taken to prevent glass from being damaged by any force that can be controlled.

Glass can be damaged in a great variety of ways, even destroyed by dropping it or subjecting it to excessive heat or pressures. However, it must be assumed that the contractor will ensure that the proper glass is selected for each installation. The glazier will also ensure that each light of glass is handled with the care required to prevent it from being broken and will make the installation so that the light will not be subjected to pressures which might cause it to crack or break. However, it cannot be assumed that all other steps will be taken to make certain that the glass is not damaged, especially while in storage on the job or after it has been installed. Only if the causes for damage are known can steps be taken to control conditions in the area where the glass is stored and to control operations in the area where the glass is installed so as to protect it from all forces that might damage it.

Protection of Glass at the Job Site

Glass must be protected from damage in all phases of its handling and storage, and protection must continue after the installation is complete. The following paragraphs will discuss the steps that should be taken to protect glass at the job site.

Storage. Responsibility for the storage of glass at the job site rests primarily with the glazing contractor. However, the general contractor must assume responsibility for making available a storage area that is adequate and satisfactory for the purpose. The glazier should be informed regarding how glass should be stored and should be prepared to advise either the general contractor or the glazing contractor regarding the storage conditions required and how they may be secured.

The storage area for glass should be located where the necessity for handling and transporting the glass is at a reasonable minimum. The area should be one that is dry and that remains dry; the humidity content of the air should be consistently low; and the temperature of the area should remain at a relatively constant level. Glass should be placed in the storage area so that the necessity of moving it except to the points of installation will be at a minimum. And the glass should be stored so that air will be constantly circulating over the glass.

Protection after installation. The glazing contractor's responsibility does not end until he has met all the requirements of the contract and the job has

been approved by the proper authority. He must, therefore, exercise every precaution to make sure that his product is protected from the time he begins work until the job is completed.

This protection will be planned to prevent any glass from being damaged by the occurrence of wet-dry stains; etching, frosting, and fogging; weathering and aging; pitting; abrasion; scratches; and impact marks or spalling (clams). He must therefore, know the causes of each of these types of impairments and the procedures to employ that will most likely prevent the different types of damage from occurring. The following descriptions of each of the types of impairments and the causes should, therefore, be of value to the contractor, the glazier, and apprentice glazier; for all must pay, in some way, for damage to material or poor workmanship that results in the cost of a job being greater than it would have been had there been no damage.

Wet-dry stains. Wet-dry stains may be caused by repeated cycles of condensation forming on the surface of glass and the moisture evaporating. As the condensation forms, a light solution of sodium and calcium is produced by these elements being leached from the surface of the glass. As the condensed moisture evaporates, the solution becomes increasingly strong; and when evaporation is completed, the precipitate has recombined with and adhered to the surface of the glass in an irregular pattern. The result is a wet-dry stain that is undesirable and that may be of sufficient magnitude to make it necessary to replace the glass.

An important consideration regarding wet-dry staining is that when a portion of a light of glass is exposed to the condensation-evaporation cycle, any stain produced may be even more noticeable because of the contrast between the stained and unstained areas. However, the important consideration in every instance where wet-dry cycles are common is to take steps to eliminate the occurrences before the glass is impaired by such staining. Certainly, when the cycle is caused in any way by the construction activities, every effort should be made to change or correct the conditions responsible.

Etching, frosting, fogging. Etching, frosting, and fogging are terms used interchangeably to refer to glass surface damage that gives the glass the appearance described by the terms. Such damage is commonly caused by marking on the glass surface with soap or by alkaline washes, such as are used in cleaning masonry, flowing onto the glass surface and drying. This damage can also be caused by fluorides from the atmosphere attacking the surfaces of the glass.

Such damage in most instances is easily avoided. For example, a glass surface should never be marked with soap. If there is danger of glass breakage caused by workmen or others failing to notice the glass because of its clearness, streamers or signs should be hung where they will direct attention to the glass installation. And when masonry is being washed, steps should be taken to make sure that the wash does not flow onto the glass and dry, or that if it flows onto the glass, the glass is washed before the mixture dries. Obviously, little if anything can be done to eliminate fluorides from the air in an area thus contaminated. But attention should be directed to the fact that etching, frosting, or fogging may be expected unless the glass is kept covered.

Surface damage. If posters, labels or slip sheets are fastened to glass with adhesives that are alkaline, the surface of the glass they contact will be affected to some extent, even though the materials are left on the glass for relatively short periods of time. If the adhesives are neutral or slightly acid, the surface opposite the one contacted will be affected. Irregular accumulations of dirt on a glass surface affect the surface in about the same way it is affected by adhesives.

Glass surface damage that is caused by fastening posters or other paper products to the surface with adhesives can be avoided by keeping the surface free of all sticky-type materials. Damage caused by irregular accumulations of dirt on the surface can be avoided by cleaning the glass surfaces often. However, as simple as these practices appear, they may not be employed unless the glazing contractor or the glazier informs those on a job of the damage that may be done to the surface of glass by sticking materials on the surface and by permitting accumulations of dirt to form and remain on the surface.

Pitting. Pitting is usually identified by what appears to be little black specks on the surface of glass. The specks may have been caused in various ways; but one of the commonest of the ways, particularly on new construction, is by welding spatter hitting the glass. The glazing contractor or glazier should, therefore, always take the steps required to make certain that any glass stored or installed in an area where welding is being done is covered or otherwise protected from being hit by welding spatter.

Abrasion. Abrasion of the surface results in the destruction of the luster and clearness of glass. Abrasion is most commonly caused by the surface being hit by wind-blown dirt and sand or by the surface being cleaned improperly. Little can be done to prevent wind-blown dirt or sand hitting glass that is installed, but some consideration should be given to the problem if heavy winds are blowing and are carrying dirt and sand that would hit glass installed in a given location. Whenever sandblasting is to be done in an area where glass is installed, the glass should be covered before the blasting is begun. In all instances, glass should be cleaned by means and methods that will not cause the surfaces to be scratched. Dirt and other rough materials should be thoroughly soaked and rinsed from the surface, never rubbed over the surface.

Scratches. Scratches are really cuts in the surface of glass. They are made by sharp-pointed hard materials being drawn across the surface or the surface being drawn across such materials when a light is being prepared for installation. The steps required to prevent scratches from occurring are difficult to enumerate. Scratches are sometimes produced intentionally, perhaps even to prove that the setting in a ring is a diamond. However, every glazier can and should handle glass with the care required to prevent the glass from being scratched. Whenever materials are being handled at new glass installations, steps should be taken to make sure that none of the glass is scratched by sharp corners of the materials being pulled across the surface of the glass or by workmen's tools coming in contact with the surface.

Impact marks or spalling. Impact marks in glass are similar to those caused by flying rocks. These marks, however, may be caused by sharp blows or

improper removal of paint, plaster, varnish, or dirt that has adhered tightly to the surface of the glass. The precautions that must be taken to avoid such marks are easily identified. In areas where there is extreme danger of the glass being hit sharp blows, the glass should be covered. For example, when concrete is being broken, small pieces of it are likely to be thrown at high rates of speed. This will cause impact marks or spalling if the glass is hit. Materials such as paint, plaster, and dirt that have tightly adhered to the surface of glass should be removed by first applying a remover to soften the materials sufficiently that they can be removed without the use of force. However, when any form of remover is used, the surface of the glass should be thoroughly cleaned so no residue that might produce undesirable effects will be left on the surface.

The Manufacture of Glass

The principal raw materials used in manufacturing glass are the highest quality silica sand, salt cake, limestone, dolomite, feldspar, soda ash, and cullet (broken glass). All the materials used are constantly protected from contamination that might result in the mixture being unsatisfactory for the production of the highest quality glass.

The manufacturer of glass has a formula for the mix or combination of the materials he uses for each pound of glass he manufactures. The completed mix of the materials is called a batch.

Usually the manufacturer employes some combination of the principal raw materials that his company has determined will produce glass that has the quality and the characteristics desired. And the manufacturer may add to the raw materials the quantity of cullet or other substance that his company has determined is essential to secure a batch that will produce glass which is free of discolorations, cloudiness, bubbles, and other flaws. Coloring materials are added when the glass is to be other than clear. The cullet used in a mix must contain the same combination of materials as that of the glass to be manufactured. The proportion of cullet used depends upon the manufacturer's formula, but it may be as much as 75 percent of the total batch. Cullet is used primarily to increase the speed at which a batch melts and to secure a uniform product.

Each ingredient in a batch has been powdered and the exact amount determined by weight. When all ingredients are in the batch, they are thoroughly mixed before the batch is moved to the melting furnace. After the batch is melted and refined, the heated glass is drawn or otherwise made into large sheets of specified sizes. These sheets are then cut to standard sizes.

Types of Glass

Many types of flat glass are employed in glazing work. The most widely used of these are window or sheet glass and plate glass, but the many special-purpose types of glass--obscure glass and tempered glass, for example--find numerous applications in modern residential and commercial construction, in consumer products, and in industry.

Window or sheet glass. Window glass is the type of glass the glazier will use most frequently. In the glazing trade, the 3/32- and 1/8-in. window glass is referred to as sheet glass, and the 3/16-, 7/32-, and 1/4-in. as heavy sheet glass or crystal. On most work orders where sheet glass is to be used, the letters SSA (single strength, grade A); SSB (single strength, grade B); DSA (double strength, grade A); and DSB (double strength, grade B) are used to specify the types of glass.

Window glass is drawn vertically and held to a flat surface from the molten state to the finished sheet, which has an unusually brilliant, unmarred finish on both sides. This glass has remarkably permanent transparency which permits true vision of shapes, actions, and colors viewed through it.

In the drawing process, wave or distortion is of the direction of the draw. Window glass should be glazed into the opening with the waves running horizontally to the sill of the window frame. When glass is ordered, the horizontal dimension is written first. For example, if the sash is 44 in. wide and 16 in. high, the dimensions are written 44 in. x 16 in. The waves will then run parallel to the sill when the sash is glazed and the light is in place.

Window glass is manufactured in the following standard qualities: (1) AA Quality--best quality window glass obtainable, made on special order only and priced accordingly; (2) A Quality--highest standard grade window glass for commercial purposes, contains no imperfections that appreciably interfere with vision; and (3) B Quality--may contain larger, heavier, and more numerous defects than A Quality.

Plate glass. Plate glass is manufactured by two different processes: rolling and floating. The rolling process is the oldest and most commonly used. The floating process, developed in England and first used by manufacturers in this country quite recently, is becoming increasingly important in the manufacture of glass.

Rolling process. In the rolling process, hot viscous glass from the furnace is fed between pairs of horizontal rollers that roll the glass into a sheet of the desired thickness. This sheet is carried by a series of rollers into lehrs for annealing (slow cooling process). At this time, the surfaces of the sheets are level or smooth, and the thickness of the glass is not uniform.

Floating process. In the floating process a continuous ribbon of glass floats on the surface of a bath of molten metal in a controlled atmosphere, and the glass emerges ready for use without grinding and polishing of the surfaces. Glass produced by this process is used only for glazing.

Plate glass is manufactured in the following standard qualities: (1) silvering; (2) mirror; and (3) glazing. Silvering-quality plate glass is free from defects that are caused by the batch-mix used or that result from any process involved in finishing the glass. This quality of glass is employed where highest quality requirements must be met. It is rarely made available for glazing purposes in sizes that contain more than 20 sq. ft. Mirror quality plate glass is specified when perfection is not required, but when a very high standard, exceptionally

free of defects, is desired. Glazing quality plate glass is of sufficiently high grade to meet the specifications for ordinary glazing installations.

Grinding and polishing. Polished plate glass is made by grinding each surface of plate glass after rolling to make it level and uniform in thickness and then by polishing both surfaces. Both the grinding and polishing are now done by two different processes. One of these involves grinding and polishing each surface separately, and the other grinding and polishing both surfaces at the same time. The latter of these is known as the twin-ground process.

When the surfaces of the glass are ground and polished separately, provision is made to hold the glass rigidly while each surface is processed. This is sometimes accomplished by setting the sheet on a flat surface in damp plaster of Paris, waiting for the mixture to dry, and then grinding and polishing the exposed surface. The grinding is done by heavy metal discs lowered onto the surface; and as these rotate, a grinding compound is fed under them and the grinding process continued until the surface is flat and even.

The heavy discs are then removed, and the surface is polished by revolving felt-covered discs; and as these rotate, fine rouge is fed under them. The process is continued until the surface is clear, brilliant, and free of all scratches caused by grinding the surface flat. After one surface is polished, the sheet of glass is turned over and set in plaster of Paris and the unfinished side ground and polished to uniform thickness. By thus making the two surfaces level and in parallel planes, the plate glass affords undistorted vision and true reflection from any angle.

Twin-roller grinding and polishing process. In the twin-roller grinding process, both surfaces of the sheet of glass are ground level, brought into parallel planes, and polished simultaneously. This process is relatively new, but is rapidly replacing the process of working each surface separately. Polished plate glass meets the highest quality standards and is therefore used wherever high quality visual performance is essential.

Heavy polished plate glass. Plate glass that has a thickness of from 5/16 in. to 1-1/4 in. is termed heavy plate glass. Since the strength of plate glass increases in direct proportion to the square of its thickness, heavy polished plate glass is commonly used where great strength is required. Its strength, true flat surfaces, great brilliance, high reflectivity, and clarity, which affords excellent vision, make heavy plate glass adaptable to many uses. In commercial, industrial, and public buildings it has proved its value where wind loads and sound reduction are problems. In addition to being used in large, unobstructed exposures, heavy plate glass is widely used for book partitions, theater marquees, valances, lighting fixtures, radio sound control rooms, refrigerator doors, showcase tops, soda fountain counters, and many similar applications. In general, heavy polished plate glass is manufactured in glazing quality only; however, it is also sometimes manufactured to meet the requirements for specified uses. Size information and other specifications for plate glass are given in Table 1.

Rough plate glass. Rough plate glass is produced entirely by the rolling process; the surfaces are neither ground nor polished. The knurled surface pattern produced by the rollers gives this glass a translucent quality, the degree of the

translucency being determined by the lighting conditions and the distance of objects behind the glass. Under normal conditions, objects more than a few feet behind the glass will appear as vague images when viewed through the glass, while objects at less distance behind it may be seen clearly enough to identify, but their detail is not apparent. Its uses include partitions, obscured windows and door panels, skylights (tempered), table tops, roofs (tempered), shelves, and trays. Rough plate glass is available in two patterns: swirl and stipple. Specifications for rough plate glass are given in Table 2.

Heat-absorbing glass. Heat-absorbing glass is made in heavy sheet, polished plate, pattern, and wire glass. This glass absorbs much of the energy of the sun without significantly interfering with visible light transmission. This type of glass transmits only about 45 percent of total available solar heat and light. Clear glass transmits approximately 85 percent of total available solar heat and light.

Heat-absorbing glass is manufactured in a bluish-green tint, bronze, and gray. The light transmission of gray glass is substantially lower than that of the other two colors. Heat-absorbing glass absorbs and retains a considerable amount of heat, and this causes an increase in glass temperatures and also temperature differences over the glass because of partial shading, particularly by store front moulding sections. It is, therefore, advisable to provide larger glazing clearances than are provided for other types of glass and to limit excessive edge cover which produces "cold edge" effects and which may result in cracking caused by the shielded edge remaining cold when the exposed area of the glass is being warmed by sunshine.

Heat-absorbing glass must have clean-cut edges. Stress concentrations on irregular edges can result in breakage after the glass is installed. For this reason, "nipping" the edge of a light of heat-absorbing glass must be avoided.

Tempered glass. For tempering, glass is reheated to just below its melting point and then suddenly cooled by air blasts or by being dipped into a special solution. As a result, fully tempered glass will support four times the weight of ordinary glass and will bend four times as far without breaking. Also, its impact resistance is eight times that of ordinary glass. Tempered glass is highly resistant to varying surface temperatures and will not break even when the temperature on one surface is 550° F. and relatively low on the other surface. Tempered glass also resists shocks and impacts as well at -65° as it does at ordinary temperatures.

Although tempered glass is three to five times as strong as annealed glass of the same thickness, it is breakable; and when broken, it cracks up in innumerable small fragments somewhat cubical in shape. Tempered glass is most easily broken by impact from a small sharp object, such as a center punch. Its resistance to impact by relatively large, smooth objects is immeasurably greater than ordinary glass. A steel ball that weighs 1/2 lb. may be dropped from an elevation of 35 ft. on tempered glass of 3/4-in. thickness without breaking the glass. This same ball, if dropped from 3 ft. elevation upon regular plate glass of 3/4-in. thickness would break the glass.

TABLE 1

Polished Plate Glass Specifications

Product	Qualities	Thickness (inches)	Recommended maximum size* (inches)		Weight lb./sq. ft.
			Standard	Special	
Regular polished plate glass (clear)	Silvering; mirror; glazing	1/8 1/4	76 x 128 130 x 218	130 x 286	1.64 3.29
Heavy polished plate glass (clear)	Commercial Selected	5/16 3/8 1/2 3/4 1 1-1/4	130 x 218 130 x 218 130 x 218 94 x 130 74 x 148 74 x 148	130 x 286 130 x 286 130 x 286 Contact Mfgr. for larger size	4.06 4.93 6.58 9.67 13.16 16.45

* Size shown untrimmed factory edge

TABLE 2

Rough Plate Glass Specifications

Product	Thickness (inches)	Recommended maximum size (inches)		Weight lb./sq. ft.
		Standard	Special	
Rough plate glass	21/64 1/2 5/8 7/8 1-1/8 1-3/8	130 x 218 130 x 218 130 x 218 94 x 130 74 x 148 74 x 148	130 x 286 130 x 286 130 x 286	Approx. same as polished plate glass

Tempered glass is easily distinguished by indentations along both surfaces on one edge of the glass, usually the short edge. These indentations are caused by the tongs which are used to support the glass while it is in the tempering process. However, these indentations will not be in evidence in tempered glass that has been produced by a new process now in use. In the new process the glass is floated on air, water, or molten metal while it is being tempered, rather than held with tongs. This process results in the elimination of: (1) warpage normally found when the tong process is used; and (2) much of the distortion normally caused by the tong process. Tempered glass is not as flat as regular plate glass, particularly along the edges and at the tong marks; however, the difference is slight. Usually, the greater thicknesses of glass have flatter surfaces than the thinner ones.

When cutting, drilling, notching, or grinding is required, it must be done before the glass is tempered. Decorative designs can be cut by sandblasting to a depth of 1/32 in. before the glass is tempered. If the sandblasted design is on only one side, the glass will be somewhat more bowed after it is tempered than would be true with clear glass, and the sandblasted tempered glass will be only half as strong as clear tempered glass of the same thickness.

Tempered plate glass does not qualify under the Underwriters Laboratory Code as fire retardant; therefore, it must never be used as a retardant. However, tempered glass will withstand temperatures up to 550° F. for considerable lengths of time and temperatures around 700° F. for short periods of time without losing its temper.

The following is a partial list of tempered glass uses in industry, construction, and commerce:

<u>Automotive</u>

- Side and back windows

<u>Railroads</u>

- Headlight lenses
- Observation windows
- Cab glazing
- Instrumental and gage covers
- Mirrors
- Sight glass
- Passenger car windows

<u>Water vehicles</u>

- Port lights
- Bridge windows
- Control room windows
- Instrument and gage covers
- Mirrors
- Sight glass

<u>Commercial uses</u>

- Shelving
- Counter tops
- Counter dividers
- General glazing
- Basketball backboards
- Entrance doors
- Hockey rink screens
- Baseball park screens
- Handball courts
- Balustrades
- Stair railings
- Push and kick plates
- Television implosion plates
- Display cases
- Shower doors and bath enclosures
- Windbreaks
- Sliding doors
- Control tower glazing
- Protective explosion windows
- Aquarium glazing

Sight Glass

- Furnace windows
- Helmets and goggles
- Fire-fighting shields
- Lehr windows
- Machine enclosures
- Crane cab observation windows
- Oven doors
- Washing machine doors
- Pool vision windows
- Wind tunnel windows
- Vending machines
- Drafting tables
- Casting plates
- Lighting fixtures
- Partitions
- Jalousies

Gauges and dials

- Steam pressure covers
- Oil pressure covers
- Electrical panel covers
- Weighing- and metering-device doors

Heat-strengthened or spandrel glass. Heat-strengthened or spandrel glass is 1/4-in. polished plate glass that is coated on the back with a ceramic frit to give it opacity and color, and then the glass is heat treated. The color is sun-fast and offers the same natural resistance to weathering, crazing, and checking as ordinary glass. It is used for spandrels and other opaque panels of curtain walls.

The heat treatment fuses the ceramic coating to the glass and greatly increases its strength. This increased strength is important, for the thermal stresses in spandrel panels are much higher than those encountered in windows. Heat-strengthened glass has approximately twice the strength of ordinary glass, but less than that of tempered glass.

There are distinct advantages in using glass for the opaque panels of a curtain-wall construction. When glass is used for the spandrel panels and the windows, the metal frames can have the same section throughout. Then enclosure of the entire building can be done at one time by one contractor, employing uniform glazing techniques throughout. When glass is used for spandrel panels, there need be no concern about corrosion, staining, or buckling.

Scattered "pinholes" in ceramic coatings, particularly in the darker colors, and some nonuniformity in the thickness of the ceramic coatings, are acceptable. However, when such coatings are viewed against a strong light, these conditions cause mottled or streaked effects. Heat-strengthened glass should, therefore, be installed only in front of a backup such as masonry or fiber glass insulation.

A minimum of 1/2-in. air space should be allowed between heat-strengthened glass and the backup material. This space should be vented to the exterior, and weep holes should be provided to drain any moisture that might collect. However, under most conditions a 1/2-in. air space will ensure sufficient air movement to carry away moisture that might condense on the back of the glass. The colored surface of heat-strengthened glass should be set to the inside.

All necessary cutting, grinding, drilling, and notching must be done before glass is heat strengthened. After glass is heat treated, its flatness is essentially the same as it was before it was treated. Also, heat-treated glass is free of tong marks and kinks commonly found in fully tempered glass.

Laminated safety glass. Laminated safety glass is made by sandwiching layers of tough, transparent, plasticized polyvinyl resin or vinyl plastic between sheets of glass and cementing them into one unit by applying heat and pressure. This type of glass will crack if it is hit with sufficient force, but the glass will be held intact by the plastic material between the layers of glass, even though the blow might cause the glass to bend considerably. The safety feature of this glass is its ability to remain intact even when badly cracked. The cracking is not considered failure.

Laminated safety glass can be fabricated in almost unlimited combinations for special effects or for use in different applications. Gray or colored glass may be laminated for use where glare and light control is needed; multiple sheets of plastic are used in the interlayers to provide for control of sound; and different materials and shapes are set in the plastic interlayers to secure various designs and effects.

Bullet-resistant plate glass. Bullet-resistant glass is exactly what its name implies. It is produced by laminating three to five lights of polished plate glass and interlayers of clear, strong sheets of plastic. These are bonded together by the application of heat and pressure, thus making a solid transparent plate that is resistant to bullets fired from the heaviest side arms, submachine guns, and high-powered rifles. This type of glass is extensively used in glazing bank-teller cages, cashier booths, jewelry display cases, observation windows, and the like.

Insulating glass units. Insulating glass units are manufactured by separating two or more lights of glass with 3/16-, 1/4-, or 1/2-in. space filled with dehydrated air that is retained by the edges of the glass being hermetically sealed with a metal-to-glass bond or glass-to-glass fused bond (Fig. F-1). The glass is specially washed, and the air scientifically cleaned and dried. On all insulating glass units, except those manufactured with window glass, the edges of the glass are protected by a metal channel that minimizes the danger of edge chipping during installation and that makes the units easy to handle.

The insulation in the unit reduces the tendency of condensation to form on the room side of the glass surface; and unless conditions are unusually severe, frost will not form on the surface. Insulating glass units reduce cold downdrafts at windows, cut down the "cold shoulder" effect, and help to maintain uniform temperature. Insulating glass units also reduce heat loss during the cold season and heat gain during the hot or air-conditioning season. Only about half as much heat is lost or gained through insulating glass as through single-glazed windows. An insulating glass unit has year-round value, for it permits the maintenance of a comfortable environment at minimum cost.

An insulating glass unit has approximately 50 percent more resistance to wind load than any single piece of glass which is used in the unit. Thus, if 1/4-in.

plate could withstand 20 psi, an insulating glass unit of the same size consisting of two pieces of 1/4-in. plate could withstand 30 psi. Where extra strength is required to withstand pressure sufficiently great to fracture the standard glass in an insulating unit, a unit made with tempered plate glass should be used. When tempered glass is used as the outer glass, the wind load resistance of the unit should be figured as that of the outer glass; no consideration should be given to inner glass.

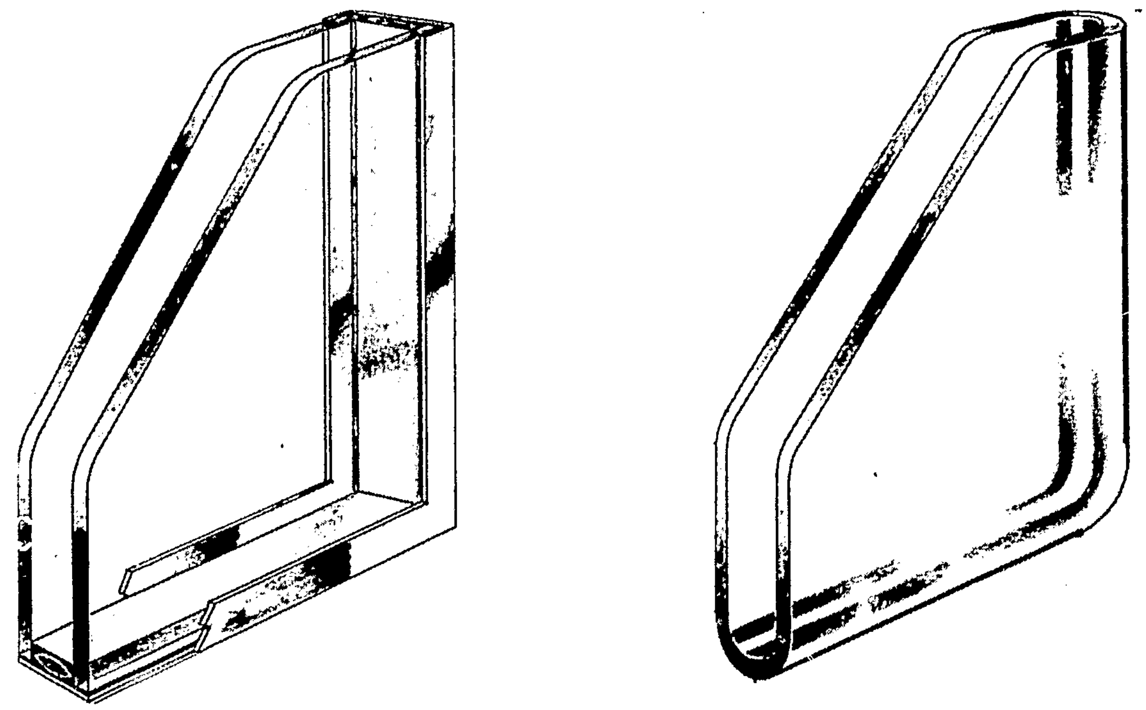


Fig. F-1. Insulating glass units

Units with metal-to-glass seal are available with various glass combinations; however, if obscure glass is used, one side of each light is smooth. In all instances, the thicknesses of the lights do not, and should not, vary more than 1/16 in. For example, a unit cannot be manufactured with one light of 1/4-in. thick glass and the other of 1/8-in. thick. Patterned glass in units of metal-to-glass seal will always be fabricated with the pattern on the outside and the smooth surface inside. Since sandblasting reduces glass strength 50 percent, glass thus finished is not recommended for insulating units. Patterned glass should be considered when obscurity is needed.

Units with metal-to-glass seal that have four or five sides are manufactured, provided that no angle is less than 45° nor any one edge less than 8 in. long. Insulating units are not manufactured in triangular, circular, or bent shapes; nor are they available with cutouts, notches, holes, or finger pulls. Triple insulating glass units in various glass combinations are available for special jobs. Insulating glass units must be ordered to job specifications. Adequate clearances and rabbet depths must be provided for all units so that the metal seal is not visible.

Patterned glass. Patterned glass is referred to by glaziers as obscure glass. This is a semitransparent glass that diffuses transmitted light and affords varying degrees of obscurity for the many requirements of decorative or functional uses. Obscure glass comes in many forms and finishes, including

standard, with natural finish; heat absorbing or heat resisting; translucent annealed or tempered; and wired (patterned or polished surface) for safety and for use as a fire retardant. It is often cut to special shapes or bent into special configurations, for use in special applications such as lighting fixtures. This is a regular rolled flat glass with an impressed design on one or both sides accomplished during the rolling process. It is available in a variety of designs and finishes. Patterned glass (sometimes called rolled, obscure, rough, or translucent glass) is used for industrial, commercial, or domestic glazing where light is required and privacy is essential.

Generally speaking, standard patterned glass is regular plain rolled glass as it comes from the rolling machines, with no additional treatment except possibly a surface satinol or frosting. This type of glass has distinctive designs or patterns in either surface or in both surfaces. Since these designs are produced in rolling the molten glass, the finish is known as "fire polish."

The surface patterns give the glass a semitransparent appearance and, therefore, varying degrees of translucency ranging from nearly clear to almost obscure. By choosing carefully the pattern design to be used, the designer can secure almost any effect he desires. The obscurity of standard patterned glass can be increased by treating the fire-polished surface as required to produce a satinol, frosted, or sandblasted surface. The translucency of glass decreases as the pattern becomes increasingly heavy. The weight per square foot of obscure glass, like that of other glass, depends upon its thickness.

Each manufacturer has its brand name for glass with similar pattern. A few of the many patterns available are shown in Fig. F-2.

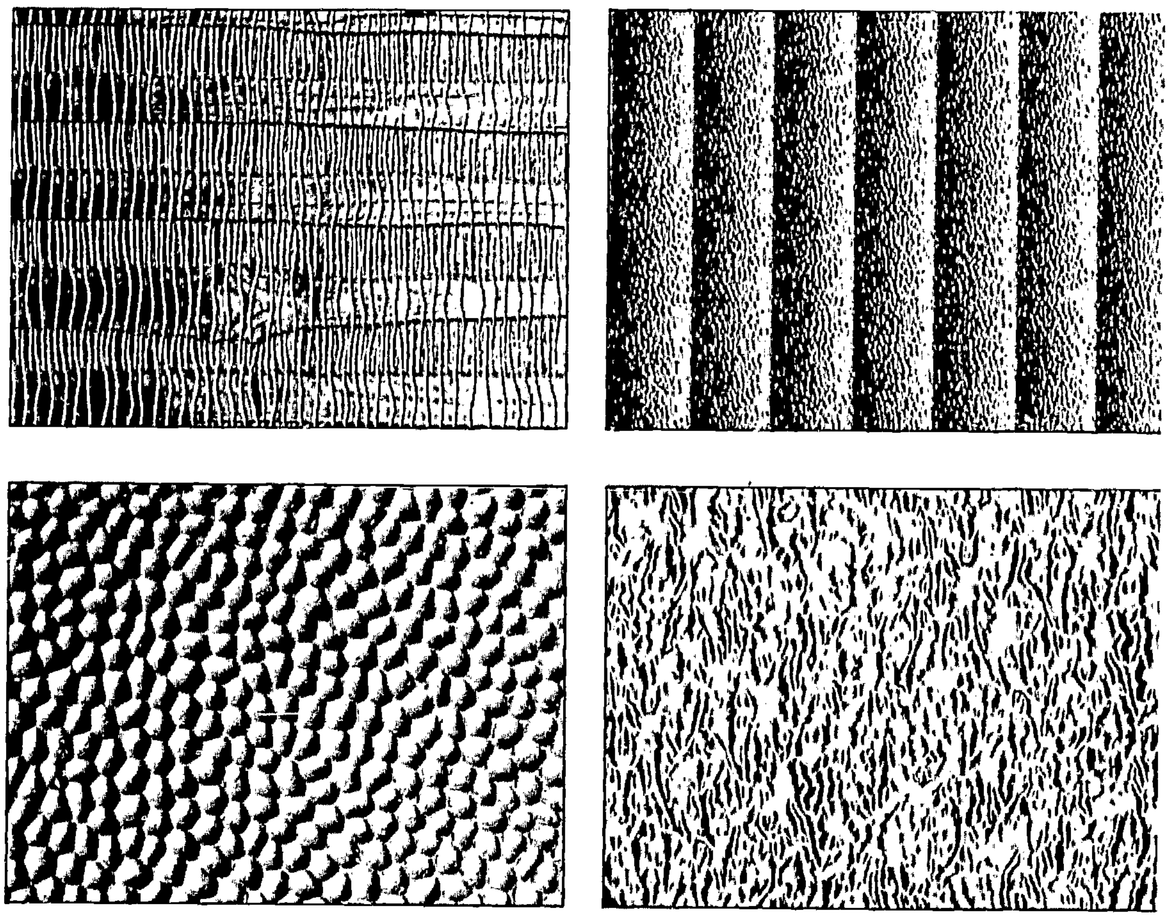


Fig. F-2. Patterned glass

Wire glass. Wire glass is a regular rolled flat glass with either a hexagonal twisted, square, or diamond-shaped, welded, continuous wire mesh imbedded in it. The wire mesh is inserted into the molten glass as it passes through the rolling machines. Annealing produces a stress-relieved flat sheet of wire-reinforced glass. The wire mesh is centered between the surfaces of the glass sheet, which makes the glass stronger than glass of the same thickness and pattern but with the wire nearer one surface than the other.

The wire does not add to the strength of the glass; however, it does hold the light in place in the frame in case of breakage. This characteristic of wire glass accounts for its being a fire retardant; whereas glass without wire, though it may be stronger, is not a "fire retardant."

American-made wire glass has proved itself as a fire retardant and thus has had the approval of the Underwriters Laboratories for more than 60 years. The permanent fire protection given by wire glass was first determined by a test given by Underwriters Laboratories. This was the basis upon which it was approved as fire retardant No. 32. The following procedure is used in making this test. Several lights of wire glass are glazed in a removable wall of a gas-fired furnace. The furnace is fired to raise the temperature of the glass to approximately 1,600° F. in 45 minutes, and this temperature is maintained for 15 minutes. At the end of this time, the removable furnace wall is moved aside, and a 1-1/8 in. stream of cold water under 35 to 40 psi of pressure is turned on the hot glass. The glass must remain in the sash in substantially unchanged condition except for cracking due to thermal shock if it is to be approved as fire retardant No. 32 by the Underwriters Laboratories.

Rules of the National Board of Fire Underwriters limit the size of wire glass that can be glazed in openings where it will be exposed to fire hazards. With Underwriters Fire Window Frame No. 1, in no case shall the unsupported area of the glass measure more than 48 in. in either dimension or exceed 720 sq. in. (5 sq. ft.). With Underwriters Fire Window Frame No. 2, in no case shall the unsupported area of the glass measure more than 54 in. in either dimension or exceed 1,296 sq. in. (9 sq. ft.). In approved fire doors the glass size will depend on the rating of the door. In no case shall the glass exceed 1,296 sq. in., and no dimension shall exceed 54 in. Local building codes may further restrict these areas and dimensions.

The ability of wire glass to remain in place after breakage fulfills the safety requirements of heavy traffic areas, such as school entrances, corridors, machine shops, and other work areas. It also meets safety requirements for sliding doors and shower enclosures in the home. The stubbornness with which wire glass withstands abuse and remains in the sash also makes it admirably suitable for protection against burglars. Wire glass is manufactured as polished plate, obscure, heat-absorbing, and glare-reducing glass.

Structural glass. Structural glass is made by the same process as quality plate glass. Metallic oxides give it its opacity and color. Structural glass has the same general characteristics as plate glass. It is manufactured in light colors, in black and white, and in thicknesses ranging from 1/4 in. to 1-1/4 in.

Structural glass has innumerable uses in building construction, interior decoration, furnishing, and industrial production. These uses include exterior and interior surfaces; panels, murals, columns; tops and sliding doors for furniture, counters, and laboratory equipment; operating and x-ray rooms; chute linings; and surface plates.

Structural glass can be bent to a specified radius; tempered or semitempered to give extra strength and resistance to thermal change; sand carved; laminated; or cut to free-form patterns. It is manufactured with a polished suede finish (in 11/32-in. thickness) and with a rough textured finish.

Mirrors

Among the types of mirrors encountered in glazing installations are conventional silver-back mirrors, mirrors with a protective copper back over the silver reflective back, window-glass mirrors, and transparent mirrors. These mirror types will be discussed in the following paragraphs.

Silver-back mirrors. Mirrors are made by a chemical process in which the silver from silver nitrate is deposited on one surface of the glass. Since the silver in the thin reflecting coat tarnishes rapidly when it is exposed to the air, a protective backing is applied directly over the cleaned and dried silver film. This coating may consist of a two-coat system of dissimilar, but compatible, protective backing material, or it may be a special backing material that is applied in one operation as a double coat.

Copper-back mirrors. Copper-back mirrors offer a high resistance to deterioration. In producing these kinds of mirrors, a double coat of silver is applied to one surface of the glass, and then a layer of copper is deposited electrolytically over the silver. Copper-back mirrors are usually guaranteed against silver spoilage from climatic or atmospheric conditions for five years from the date they are manufactured. Copper-back mirrors are not guaranteed when installed in bathrooms or showers where moisture is excessive, nor when they are installed on the exterior of buildings where they are exposed to the elements. Polished plate glass of silvering quality or mirror-glazing quality is used to make high-grade mirrors.

Window-glass or shock mirrors. Window-glass or shock mirrors are produced by silvering one surface of window glass. In such mirrors, reflection is generally wavy, and images are usually distorted.

Transparent mirrors. A transparent mirror serves as a mirror when viewed from one side, but the mirror is transparent when viewed from the opposite side. In effect, such a mirror is a "one-way mirror" when properly installed. This effect is produced by applying to one surface through thermal evaporation a special chrome alloy in a coat that is thin enough to be transparent.

The results obtained from a transparent mirror are directly proportional to the degree of difference in illumination on each side of the mirror. Ideally, the mirror side should be brightly lighted with dimmed lighting on the opposite side. Observers on this darker side then have a perfect view through the glass

and into the lighted side. Those on the illuminated side will have only a good mirror (Fig. F-3).

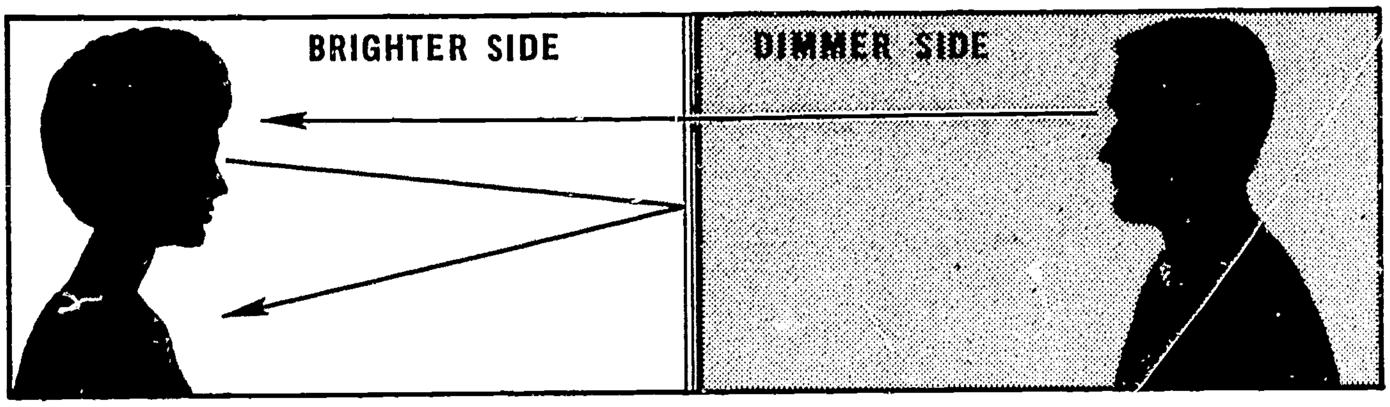


Fig. F-3. Transparent mirror

Where the necessary differential of light intensity between the two areas involved is not available, a transparent mirror made of 1/4-in. grey polished plate glass should be used. This glass is available in any size up to a maximum of 72 in. x 96 in.

To be fully effective, transparent mirrors on regular plate glass require a 10 to 1 light ratio on opposite sides, but in most cases a 5 to 1 ratio will work satisfactorily. With grey glass, positive effectiveness is obtained with as little as a 4 to 1 light ratio, and a 2 to 1 ratio will work satisfactorily. In many installations, the use of grey glass, therefore, has a definite advantage.

Where additional strength and/or safety are desired, transparent mirrors are available on tempered plate glass which is from three to five times stronger than regular plate glass of the same thickness. The modulus of rupture of 1/4-in. polished plate glass averages 6,000 psi, compared with an average of 30,000 psi for 1/4-in. tempered plate. When fractured, tempered glass does not disintegrate into sharp, dangerous splinters, but into relatively small harmless particles.

Mirror glass is also available either on one of the outside surfaces of laminated safety glass or laminated between the two pieces of glass. The two lights of glass in safety glass are laminated with a clear, tough plastic between them. If the glass is broken, the pieces cling to this plastic interlayer, thus preventing any hazard from falling glass. This feature of safety glass is a great safety factor.

Transparent mirrors are used in many locations and for many purposes, and new uses are constantly being found for them. Some of these uses are the following:

Residence entrance doors	Ambulance windows
Hospital observation windows	Colleges and universities
Shop windows	Toll houses
Variety chain stores	Elementary and high schools
Supermarkets	Nightclubs and taverns

- Department stores
- Commercial refrigerators
- Nursery doors in residences
- Residential shower doors
- Factories and institutions
- Security windows in government buildings
- Offices
- Banks
- Post offices

Bending Glass

All kinds of glass can be bent or curved, including window glass, plate glass, and structural glass. However, the maximum size of glass that can be bent is 150 in. x 180 in.

How glass is bent. Bending or curving of a flat sheet of glass is done by reheating until it softens and sinks, taking the shape of the mold onto which it is placed. After bending, it is carefully annealed. Plate glass is the best type of transparent glass for bending.

Sizes of curves. It is necessary that a pattern or template be used in all cases for bending or curving glass, even when regular curves are being made. It is not recommended that plate glass be bent to a curve exceeding a half circle, nor to acute bends approaching right angles. Making such extreme curves involves great risk of glass breakage and of damage to polished glass surfaces. Segments of ellipses, parabolas, and compound curves can also be obtained by bending. It should be noted that curves may be made sufficiently accurate for all practical purposes. Plates with openings or speaking holes cut for information booths, bank fixtures, ticket offices, and the like cannot be bent without great risk of breakage. In ordering glass with standard bends, the drawing of the desired bend should be used. Some standard bends that are made are shown in Fig. F-4.

Acrylic Plastics

When used for sidewall window glazing, skylights, doors, and partitions in industrial plants and schools, plastic reduces the inconveniences and the hazard of frequent window breakage. Although plastic is stronger than glass, it is not unbreakable. However, when plastic breaks, it breaks into large dull-edged pieces, rather than into sharp fragments like those from ordinary glass.

Acrylic plastic is a rigid, resilient, weather-resistant sheet material. It is supplied as a colorless transparent material and also in a variety of tints and translucent colors. It is manufactured in thicknesses from 1/16-in. to 4 in. and in standard sizes up to 67 in. x 102 in.

The degree of stiffness of plastic is about one-twentieth that of glass. Plastic expands and contracts, because of temperature changes, eight times as much as glass. This wide range of expansion and contraction may cause the plastic to break the seal of the glazing compound over a period of time.

Elastic (nonhardening) glazing compound should be used at all times to prevent breaking such seals.

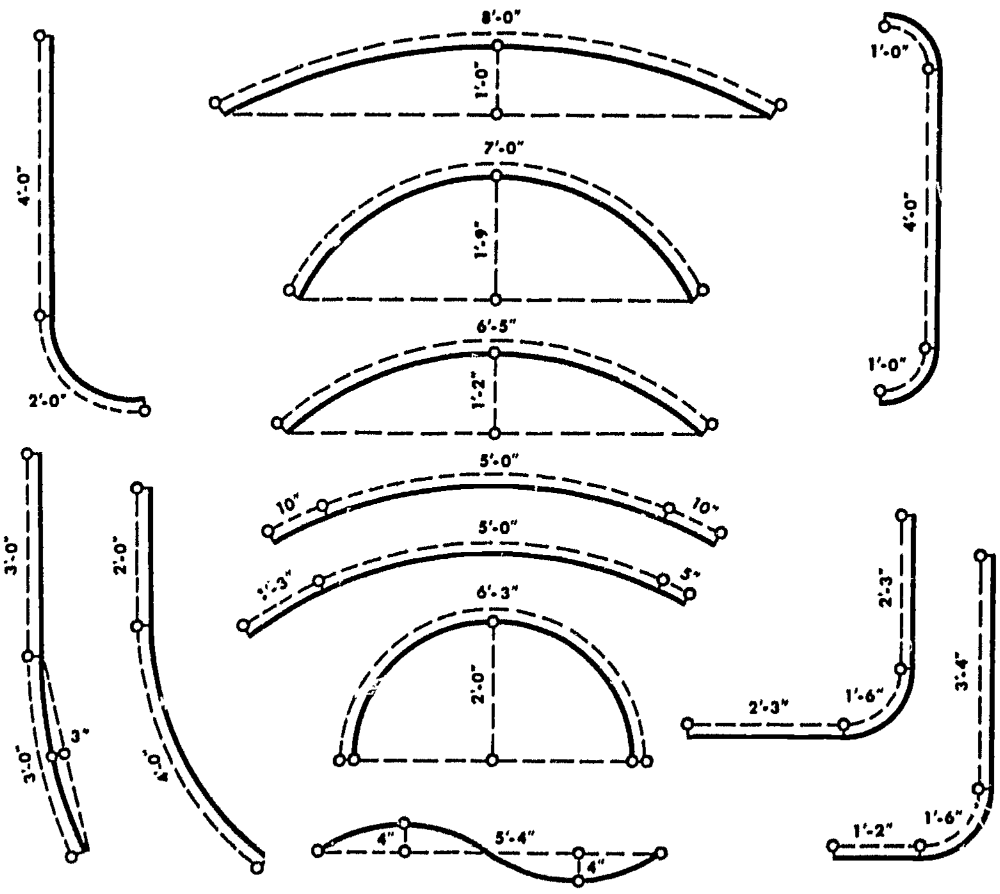


Fig. F-4. Typical bends for glass

Plastic should be cut with a circular saw or bandsaw. If the plastic is cut with a circular saw, the blade should be 8 in. to 10 in. in diameter, 3/32-in. to 1/8-in. thick, and should have 6 to 8 teeth per inch alternately set and filed radially. Regardless of whether a circular saw or bandsaw is used, it should be operated at approximately 8,000 to 12,000 feet per minute. To prevent chipping of the plastic, the height of the circular saw blade above the table should be slightly greater than the thickness of the plastic sheet being cut.

Plastic is a combustible material classified as slow burning. Nevertheless, it can be a fire hazard.

Different temperature and humidity conditions on the inside and outside surfaces of plastic may cause the sheet to bow somewhat in the direction of the higher temperature or humidity. However, the plastic will return to approximately its original flatness when the temperature and humidity conditions on both sides are equalized. Bowing does not affect visibility through the material but will cause distortion.

Since plastic has a much softer surface than glass, a razor blade or other sharp instrument should not be used to remove dirt or other deposits from its surface.

In outdoor use where temperature varies widely, plastic should be handled in accordance with the following:

1. Plastic sheets or panels should be installed in a channel frame engaging the edges of the material, so that it is free to expand and contract without restraint.

2. The channel frame should be sufficiently deep to allow for thermal contraction of the plastic without withdrawal of the edges from the frame.

3. Through-bolting or other fastenings should be installed so as to provide for expansion and contraction. Inflexible through-bolting and fastenings may cause failure of the installation.

4. Before installation in the channel frame, plastic should be cut so as to have sufficient clearance inside the channel frame to allow for thermal expansion.

5. Plastic should be sealed with sealant compounds and tapes which are flexible enough to accommodate thermal expansion and contraction.

Study Assignment

1. Glazing Manual. Topeka: Flat Glass Jobbers Association, 1965. Read pp. 1-3, "Types of Glass and Descriptions Thereof"; p. 10, "Strength of Heavy Glass"; and pp. 12 and 13.

2. Architectural Data Handbook. Pittsburgh: Pittsburgh Plate Glass Company, 1965. Read the descriptive material on flat-glass products, pp. 5-47.

3. Glass for Construction. Toledo: Libbey-Owens-Ford Glass Company, 1965. Read the descriptive material on flat-glass products.

4. Read descriptions of flat-glass products in other catalogs and manuals prepared by American manufacturers of flat glass (American Saint-Gobain Corporation, Mississippi Glass Company, and others).

UNIT F--MATERIALS

TOPIC 1--GLASS AND RELATED MATERIALS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. In the glazing trade, 3/32- and 1/8-in. window glass is called ____1____ glass; 3/6-, 7/32-, and 1/4-in. window glass is called heavy ____2____ or ____3____.	1. ____________ 2. ____________ 3. ____________
2. The principal materials used in the making of glass are high quality ____4____ sand, salt cake, ____5____, dolomite, ____6____, soda ash, and ____7____.	4. ____________ 5. ____________ 6. ____________ 7. ____________
3. The best quality window glass is designated as ____8____ quality.	8. ____________
4. Window glass should be ____9____ with the waves running ____10____.	9. ____________ 10. ____________
5. To smooth the surfaces of plate glass and make them parallel, the glass must be ____11____ and ____12____.	11. ____________ 12. ____________
6. Plate glass is available in three qualities: ____13____, mirror-glazing, and ____14____.	13. ____________ 14. ____________
7. After plate glass has been ____15____, it is polished by means of ____16____ covered discs.	15. ____________ 16. ____________
8. In the float process, the plate glass, like window glass, is not mechanically ____17____ and ____18____.	17. ____________ 18. ____________
9. Plate glass in thicknesses of ____19____ to ____20____ is termed heavy plate glass.	19. ____________ 20. ____________
10. Rough plate glass, due to its textured surface, is ____21____ rather than ____22____.	21. ____________ 22. ____________
11. Pitting is a surface defect often caused by ____23____ ____24____.	23. ____________ 24. ____________

12. Heat-absorbing glass is manufactured in heavy sheet, __25__, polished plate, and __26__ glass. 25. ______ 26. ______

13. Glass surfaces should never be marked with __27__. 27. ______

14. Heat-absorbing glass transmits about __28__ percent of total available solar heat and __29__. 28. ______ 29. ______

15. In cutting heat-absorbing glass, __30__ cut edges are required; therefore, __31__ must be avoided. 30. ______ 31. ______

16. In the first step in tempering glass, it is __32__ to just below the __33__ point. 32. ______ 33. ______

17. Tempered glass is __34__ to __35__ times stronger than annealed glass of the same thickness. 34. ______ 35. ______

18. In no sense should tempered glass be considered a __36__ __37__. 36. ______ 37. ______

19. In the last step in tempering glass, the hot glass is suddenly __38__ by __39__ blasts or by being dipped in a special solution. 38. ______ 39. ______

20. Tempered glass cannot be made as __40__ as other glass, particularly about the __41__. 40. ______ 41. ______

21. Tempered glass is easily __42__ by impact from small __43__ objects. 42. ______ 43. ______

22. Heat-strengthened glass has approximately __44__ the strength of ordinary glass, but its strength cannot equal that of __45__ glass. 44. ______ 45. ______

23. Spandrel glass is coated on the back with a __46__ frit to give it opacity and __47__. 46. ______ 47. ______

24. Spandrel glass cannot be cut, nipped, ground, drilled, or notched after __48__ __49__. 48. ______ 49. ______

25. Heat-strengthened glass is free from the __50__ marks and __51__ often associated with fully tempered glass. 50. ______ 51. ______

26. A minimum of __52__ of __53__ space is recommended between heat-strengthened glass and the backup material. 52. ______ 53. ______

27. Laminated glass consists of two or more sheets of __54__ with a layer of tough, transparent __55__ sandwiched between the adjacent sheets. 54. ______ 55. ______

28. Laminated glass is cemented into one unit by the application of __56__ and __57__. 56. ______ 57. ______

29. If gray or colored glass is used in its manufacture, safety glass can control __58__ and __59__. 58. ______ 59. ______

30. Bullet-resistant glass is built to resist the impact of bullets from the heaviest __60__ arms and from __61__ guns and high-powered rifles. 60. ______ 61. ______

31. The interlayer of laminated glass is a plasticized __62__ resin or __63__ plastic. 62. ______ 63. ______

32. Insulating glass is essentially two pieces of glass __64__ by 3/16, 1/4, or 1/2 in. of __65__ air space. 64. ______ 65. ______

33. Insulating glass is __66__ sealed around the edges with a metal-to-glass or __67__ bond. 66. ______ 67. ______

34. Insulating glass units with metal-to-glass seal can be produced in __68__ __69__. 68. ______ 69. ______

35. Corner angles on insulating glass units cannot be less than __70__, and no edge can be less than __71__ in length. 70. ______ 71. ______

36. In the glazing trade, patterned glass is referred to as __72__ __73__. 72. ______ 73. ______

37. Patterned glass has a __74__ polished finish. 74. ______

38. Patterned glass is a regular rolled flat glass with an impressed __75__ on one or both __76__. 75. ______ 76. ______

39. Obscure glass is __77__ glass that diffuses transmitted __78__. 77. ______ 78. ______

40. Glass with a __79__ patterned surface is more obscure than that with a relatively __80__ surface. 79. ______ 80. ______

41. In wire glass, the wire mesh is inserted into the __81__ glass as it passes through the __82__ machines. 81. ______ 82. ______

42. The wire mesh in wire glass is either __83__, hexagonal twisted, or __84__ shaped. 83. ______ 84. ______

43. Over the years, wire glass has proved itself as a(n) __85__ __86__ material. 85. ________ 86. ________

44. Wire glass is manufactured as __87__, __88__, heat-absorbing, and glare-reducing glass. 87. ________ 88. ________

45. The wire mesh in wire glass is __89__ between the surfaces of the glass. 89. ________

46. Structural glass is made by the same process as quality __90__ __91__. 90. ________ 91. ________

47. Structural glass comes in thicknesses ranging from __92__ to __93__ in. 92. ________ 93. ________

48. Plastic expands and contracts __94__ times as much as glass through __95__ changes. 94. ________ 95. ________

49. Plastic is cut with a __96__ saw or a __97__ saw. 96. ________ 97. ________

50. Plastic is a __98__ material, but it is __99__ burning. 98. ________ 99. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Glass is a combustible material that burns slowly.	1. T	F
2.	Window glass is usually referred to as sheet glass.	2. T	F
3.	Window glass should be glazed with the waves running horizontally.	3. T	F
4.	The "A" quality is the best window glass obtainable.	4. T	F
5.	Plate glass is vertically drawn.	5. T	F
6.	The float process was developed in the nineteenth century.	6. T	F
7.	Polished plate glass has no waves or visible distortion.	7. T	F
8.	Glazing-quality polished plate glass is used in the making of mirrors.	8. T	F
9.	Rough plate glass has a patterned surface.	9. T	F
10.	Rough plate glass is essentially the first product obtained in the cycle of producing polished plate glass.	10. T	F
11.	Heat-absorbing glass transmits only 45 percent of the total available solar heat and light.	11. T	F
12.	Clean-cut edges are required with heat-absorbing glass.	12. T	F
13.	Tempered glass can be broken only with blows from small, sharp objects.	13. T	F
14.	The glazing shop can sandblast tempered glass to a depth not to exceed 1/32 in.	14. T	F
15.	Tempered glass is a fire-retardant glass.	15. T	F
16.	Heat-strengthened glass should be cut on the job site to ensure perfect fit.	16. T	F
17.	Heat-strengthened glass has approximately twice the strength of ordinary glass.	17. T	F

18. Bullet-resisting glass is a 2- to 3-in. -thick piece of polished plate glass.	18.	T	F
19. One kind of laminated safety glass can be used to control sound.	19.	T	F
20. The air space between the pieces of glass in an insulating glass unit is vacuum sealed.	20.	T	F
21. Triple insulating glass units in various glass combinations are available.	21.	T	F
22. Pattern glass has a fire-polish finish.	22.	T	F
23. Obscure glass can have the pattern impressed into one or both sides.	23.	T	F
24. Wire glass is a fire-retardant glass.	24.	T	F
25. The wire in wire glass does not add to the strength of the glass.	25.	T	F
26. Structural glass is another name for plate glass.	26.	T	F
27. Structural glass is made by the same process as patterned glass.	27.	T	F
28. Plastic should be cut with a sharp glass cutter.	28.	T	F
29. Plastic expands and contracts with temperature changes eight times as much as glass.	29.	T	F
30. Elastic (nonhardening) glazing compounds should be used with plastic glazing materials.	30.	T	F

UNIT F--MATERIALS

TOPIC 2--GLAZING SEALANTS

This topic, "Glazing Sealants," is designed to help you find answers to the following questions:

- What are the various kinds of glazing compounds and sealants?
- Why are glazing compounds and sealants needed?
- What qualities in modern sealants are not only desirable but necessary?
- How are glazing compounds and sealants tested for the necessary qualities?
- How are surfaces prepared for the application of sealants?

Modern Building Sealants

With the advent of curtain-wall construction methods and the growing use of large precast panel sections, obtaining suitable caulking or sealing materials became very important. In the last ten years several new types of caulking or sealing materials have been developed and made available in attempt to meet this new demand. These new materials will be discussed in this topic.

The so-called flexible or nondrying caulking compounds came into use many years ago to replace the older hardening types which shrank on final drying, did not adhere to surfaces, and usually broke up and fell from openings. The drying-type caulking compounds had been developed to replace oakum or similar materials which were driven into the cracks by appropriate hammers and chisels. This practice was developed in boat building and was adopted later for sealing dwellings.. Early in this development, mixtures of clay and straw, mud, natural bitumens, and so forth were used as sealants.

When the limitations of hard caulking compounds became apparent, nondrying compounds, based on linseed or similar oils, were developed. These are simple mixtures of oil and fillers, which are soft enough to be forced through a quarter-inch nozzle by the 20 to 30 psi of pressure generated by a caulking gun. Since the oil does not dry, or at least dries very slowly, the compound remains soft and, therefore, lasts for a considerable length of time. Actually the oil in a "nondrying" compound is a drying oil, but it requires many months (even years) for air to penetrate the mass, so that the compound forms a skin and then remains soft. It is flexible but has a very limited elongation. As the oil in the compound dries, the compound may develop considerable brittleness and lose its flexibility.

With a gradually developing need for better caulking compounds, some of the more modern resins have been used to replace the drying oils. These give caulking materials better flexibility and elongations up to 100 percent. The

best of this group of sealants is probably butyl rubber. In this compound the oil is replaced by a solvent system which contains raw butyl rubber and a catalyst. After the butyl rubber compound is applied, the solvent in the compound is lost over a period of weeks. During this time, the caulking compound is similar to the oil type. After the solvent has evaporated, the rubber slowly cures, so that finally a highly filled, cured rubber remains. Such a seal has some flexibility and elongation. Adhesion is obtained through the addition of various saturated adhering agents such as terpene resins. Polymer systems such as a polyvinyl chloride, polyvinyl acetate, acrylate resins, and synthetic rubbers of various types--for example, neoprene and hypalon--have been used to develop similar caulking materials.

Asphalts and tars, used in the past to seal older type structures, are in popular use today for sealing highway openings. However, since the bitumens soften and run when warm, they are not useful for sealing vertical joints. Combining asphalts with epoxies or other resins results in a material which will set up rapidly and which has long resistance to weather. Natural asphalt or coal tar polymerizes very slowly when exposed to air. When this oxidation is complete, the product is hard and brittle, but such a hardening process may take years. Until oxidation is complete, the bitumen-based caulking compound has good adhesion and is flexible. It does not crack and will stretch somewhat. Such material also retains ability to flow, and splits or cracks will close up if surfaces remain clean.

In modern building construction, openings between sections will vary from 1/2 in. to 1-1/2 in. due to thermal changes; therefore, highly flexible sealing materials are needed if water is to be prevented from entering.

In developing new materials to meet this demand, the chemists first turned to a Thiokol synthetic polysulfide rubber sealing compound which had limited uses as a gasoline-resistant material and which is best known as the "body" of solid fuel propellant used by the manufacturer (Thiokol Chemical Corporation) of the sealing compound. One form of the Thiokol sealant was a liquid material which polymerizes slowly (2 to 12 hours) to a soft rubber when in contact with certain catalysts. From this knowledge the chemists developed a "two-part" caulking compound. The glazier uses this compound by mixing two liquids just prior to use of the compound. These liquids mix readily and partially react chemically. The first reaction creates a viscous mass which does not flow but which can be forced into a gun and applied to surfaces. Then a second or rubber reaction takes place, and a true sealant results. By proper compounding, adhesion and a sealant bond of as much as 500-percent elongation can be obtained.

The first modern caulking compound opened a whole new field of endeavor for chemists and made possible the weatherproofing of many new types of construction. These new caulking materials are now called "sealants," a term which is more descriptive than "caulking compound" when their purpose is considered.

Properties of Sealants

A few of the scientific or technical terms used to describe the various properties of sealants should be considered at this point for an understanding of the desirable properties being sought in sealants.

Adhesion. Adhesion is the force by which one material attaches itself to another. It is usually measured in pounds per square inch (psi). For sealants, an adhesion of 50 to 100 psi is good--usually very good.

Cohesion. Cohesion is the force by which a material holds itself together. If the cohesive strength of a material is overcome, the material will tear or split. Obviously, the adhesion and cohesion of a sealant are related in actual use, since good adhesion is of no value if cohesion lets the material tear. Chewing gum is an example of a material having good adhesion and poor cohesion.

Elongation. Elongation is ability of a material to stretch without breaking. Elongation is measured in percent, and a material of 200-percent elongation is simply one that can be stretched three times its original length without breaking. However, for sealing purposes elongation must be accompanied by recovery; that is, the sealing compound must tend to go back to its original size and length. A good illustration is the comparison of a rubber band, which has good stretch and recovery, and chewing gum. The gum has stretch, but it has no ability to recover.

Modulus of elasticity. Modulus of elasticity is the ratio of stress to strain or the measure of elasticity of a material. A material of low modulus of elasticity is soft and stretches easily but recovers its original shape and length. A material of high modulus of elasticity requires more force to get elongation, but should still recover th · original shape and length.

Hardness. Hardness of a material is measured by the force required to move a small part of the mass in relation to the whole mass; that is, by the amount of force needed to put a certain size dent in the finished or cured piece. In one method of measuring hardness, the scale of measurement is arbitrarily set from 0 to 100. This method is called the Shore A hardness test, and the scale is called the Shore A scale. On this scale the soft rubber of a crepe shoe sole is about 25, and an automobile tire would be 75 or 80.

Ultimate. Ultimate is a term that designates the measurement taken at the end of the test when the speciman either fails and breaks or can go no further.

Tensile strength. Tensile strength is an expression used to designate the force required to break an object by pulling it apart. Such a test is called a tensile test. However, other ways are used for testing strength of materials and of bonds besides pulling them apart. One of these is a test based upon shear, where the pull is at a specified angle to the material or joint being tested.

Testing of materials. The discussion of qualities of materials and testing used to evaluate those qualities is very important in considering caulking and sealing compounds. When a joint is tested, it is placed in a machine which measures force and distance of movement. Then, the machine is started, and the pull on the material begins. As the force increases, the sealant stretches. At 100-percent elongation, the force is 25 psi; and at 200 percent it is 60 psi. At 250 percent and 90 psi, one side of the joint separates at the bond. From the example, the following is evident: (a) the ultimate elongation of the sealant is over 250 percent (the break being in the bond, not the sealant); (b) the adhesion

is 90 psi; (c) the cohesion of the sealant is over 90 psi; (d) the elongation at 90 psi is 250 percent. If the sealant had failed instead of the bond, (a) the ultimate elongation of the sealant would be 250 percent; (b) the bond strength or adhesion would be over 90 psi; and (c) the cohesive strength of the sealant would be 90 psi.

The adhesion of organic substances to inorganic surfaces is basically dependent on surface energy phenomena. Only with a few bonding agents, such as the urethanes, is an actual chemical bond possible; and this chemical bond is to the surface water layer only. The adhesion of sealants to surfaces depends more on the development of energy bonds, and in many cases such bonding is made difficult by the nature of the surfaces.

Primers

To minimize bonding difficulties caused by the surfaces to be bonded, primers have been developed over the years. For a long time various rubber solutions or cements have been used to assist in bonding materials to concrete or wood surfaces. The rubber cements seal the surfaces and penetrate the pores; the sealant then adheres to the rubber fac.. However, rubber cement has no power to bond smooth metal and glass surfaces, but such highly polar materials as isocyanates and silanes serve as primers for these surfaces.

The use of primers with modern sealants is essential. The force applied to a sealant bond is directed entirely to the interface between the sealant and the substrate. Since the sealant must have a reasonable modulus of elasticity if it is to have any cohesive strength at all, the interface force can be minimized but cannot be eliminated. To have this bond hold when the face is smooth, a high-energy primer or coupling agent is needed.

Primers are of value on concrete and wood even though the surface is porous, since they help to seal such a surface. Glass, when primed properly, presents a surface to which excellent bonds can be made. Since the bond to glass is often exposed to ultra-violet light, which has a very serious deteriorating effect, the bond to glass deserves extra consideration.

Aluminum and copper alloys, if bare metal, expose an oxide surface which can be either primed or sealed directly. Since the surface is smooth, primers give a strong bond. Stainless steel, like glass, adheres to little except polar primers.

Development of New Sealants

The search for new sealants with good adhesion, cohesion, and elongation was opened up by the success of Thiokol-based sealant material and the desires to meet the points where Thiokol sealant was presumably deficient. The search was given great impetus by the sudden increase in the price of sealants from between 20¢ to 30¢ per pound to between \$3.00 and \$5.00 per pound; the demand at these high prices shows that the users would pay for quality. The properties which were sought after were: (1) freedom from on-site mixing; (2) freedom from staining of white substrates; (3) consistent rate of flow or viscosity;

(4) nontoxicity of material; (5) freedom from bad odor, inherent in sulfur compounds; and (6) better price.

Silicone rubber sealants. Silicone rubber sealants are very expensive; and though industry has been willing to pay for quality, some question exists as to how much. The next new sealant to be developed, a silicone rubber, was of excellent quality. It cost up to twice as much as Thiokol sealants; however, it had the advantage of being a single-component type. It smelled of acid but was consistent and did not stain. With excellent handling properties, color, good adhesion, and appearance, the silicones became a significant factor in the market, taking 20 to 30 percent of the business from the Thiokol sealants.

The chief advantages of silicones as glazing sealants are resistance to temperature extremes, weathering, and aging; easy release; good insulating properties; and water repellency. These materials contain man-made polymers that combine the best properties of certain organic and inorganic substances. The organic part of the polymer consists of one or more hydrocarbons, which give these sealants their flexibility. The inorganic component, silicon, is the most abundant solid element on earth, accounting for about 28 percent of the earth's crust. Linked with oxygen, it provides the sealant with its resistance to heat and cold, as well as its relative immunity from the effects of time and exposure to weather.

Several other materials have chemical properties which seem to make the materials adaptable to sealant manufacture, considering the six points that have been enumerated and also considering that a good product must have good adhesion, cohesion, elongation, and reasonable hardness characteristics. The materials must retain these properties for many years while exposed to the elements. These systems are acrylic copolymers, urethanes, and epoxies. Of these, the first two have been developed, and new epoxy resins make the development of the third likely soon.

Acrylic copolymers. An acrylic sealant material, now on the market, has taken a considerable volume of the sealant business. Newer Thiokol sealants are now one-part types so that on-site mixing is unnecessary. These sealants discussed compose the current lineup of sealants. Certain likes and dislikes for these materials are based on their good and supposed bad properties: odor, rate of cure, flow, viscosity-temperature behavior, staining, adhesion, and others.

Urethanes. The urethane sealant system is probably the most versatile chemical system to be made available on the commercial market for many years. It has been manufactured in many forms: soft foams, hard foams, molded items, adhesives, coatings, tires, and many others. Its use has grown from nothing to almost 500,000 pounds in ten years.

Two-part type urethane sealants came easy and early; and like two-part Thiokol sealants, nothing about them excited the user. But a one-component system was developed, and the chemistry which permits of so much variation is still being utilized in development of new products.

Unlike other one-part sealants which cure by air- or moisture-activated catalysts, the urethane sealant molecule itself reacts with the moisture of the air. The degree of reaction of the molecule is thus subject to many variations, which makes easy the creation of special properties, various hardnesses, and almost any desired behavior.

Butyl rubber sealants. Butyl rubber sealants are manufactured in a variety of forms: caulking, mastic, and glazing tapes; extruded, solid, and sponge shapes; and calendered sheeting. Butyl rubber is used in varying percentages as the binder for a number of caulking and sealing compounds on the market today. These butyl-based materials fill the caulking and sealing gap that exists between conventional oil-based caulking compounds and the new polysulfide sealants. The adhesion, dimensional stability, and life of butyl-based caulking compounds far exceed the performance of oil or alkyd-based caulking compounds. The butyl-based compounds are recommended for installations where a material of greater durability or elasticity than oil or alkyd-based compounds is desired and where cost or technical requirements do not justify the use of the more expensive polysulfide sealants. While tapes can sometimes be put into place more quickly than a caulking compound, the use of tapes is more often associated with a specific application or design that takes full advantage of the preformed shape. Butyl-based caulking compounds and sealants are one-part plasticized butyl rubber combined with suitable inert fillers and solvents to either gun- or knife-grade consistencies.

These compounds are designed to utilize the inherent advantages of butyl rubber in obtaining a caulking material which gives outstanding performance many times longer than conventional oil-based caulking compounds.

Sunlight and weather are known to have rapid deteriorating effects on natural rubber and on many synthetic materials. However, because of its low degree of chemical unsaturation, butyl rubber has an inherent resistance to attack by sunlight and weather. This resistance has made butyl rubber a natural choice for applications requiring exposure to the elements. Because of its tightly packed molecular structure, butyl rubber is remarkably impermeable to vapors, gases, and moisture. The excellent impermeability of butyl rubber has been demonstrated for many years in auto inner tubes. As a caulking binder, this long-lasting barrier to gas and moisture continues to give outstanding performance. The expected life of butyl-based caulking compounds is as much as five times that of oil-based materials.

Since butyl-based caulking materials are nonoxidizing, they depend on solvent evaporation in order to set up. Since the butyl binder does not react chemically with the solvent, the caulking compound retains its resilient characteristics permanently. Initial set occurs after about 24 hours. Shrinkage of the caulked joint is minimal, being less than 5 percent in most cases. Nonsagging flexibility and adhesion is retained over a wide range of temperatures.

Butyl-based caulking compounds may be applied with conventional caulking guns, cartridge or pressurized bulk applicators, and by thumbing and knifing. They are nontoxic, nonstaining, nonirritating to the skin and are free from objectionable odor. Excess caulking and smearing may be easily cleaned with

aromatic solvents or mineral spirits. No elaborate joint preparation, masking, or priming are required prior to application. Since butyl-based compounds have a one-part system, mixing is not required; and additives or accelerators are unnecessary. Also, container life is indefinite.

Caution should be taken in the use of butyl-based caulking material in curtain-wall sealing. This type of construction is subject to a great deal of vibration and movement, particularly high-rise buildings. Butyl based caulking compounds have sufficient elongation to compensate for building movement, but do not have full return after tension has been released. The elongation of butyl compounds is about 200 percent, and the return is about 15 percent.

Painting of butyl caulking is not required, but, if desired, it may be accomplished after full setting-up occurs or after about one week.

Butyl-based caulking compounds should not be applied in beads less than 1/4 x 1/4 in. No fills should be deeper than 1/2 in., and a fill should have a bonding surface of six square inches for each cubic inch to fill. If volume exceeds this, two applications of compound are advisable. Butyl-based caulking compounds need no more surface preparation than conventional caulking; that is, a wiping out of all openings with clean cloths to remove grease, oil, dust, and moisture. No priming is required, since these compounds are self-priming. Cleanup of waste material is best done about a day after application of the compound. Material that has not been pressed against the surfaces may be rolled off with a dry cloth or knife.

Glazing tape. Butyl rubber glazing tape comes in many sizes, shapes, and colors; but these basically are very similar. Glazing tape is used mostly on preglazed sash in place of bedding putty. It is also used for sealing of panels, mullions, metal-lap or other joints and for filling and sealing openings in metal construction, as a protective seal, or as a cushion between metal or glass and metal surfaces to eliminate vibration and dust.

Glazing tape will not run or melt in the sun or in very high temperatures, and it remains flexible and adherent in low temperatures. Most good glazing tape will not bleed or stain finished surfaces, and it can be painted as soon as it is applied. It adheres to all types of clean, dry, oil- and dust-free surfaces, such as glass, aluminum, stainless steel, porcelain, enamel, and the like. Care must be taken to thoroughly clean the surface to be taped of all moisture, dust, or oil substances. Some advantages of using glazing tape are the following: (1) easy and rapid application; (2) no cleanup problems; (3) good adherence to most clean, dry surfaces with only slight pressure; (4) no susceptibility to sagging or running from joints when subjected to sandwiching action; (5) ability to be used alone or in combination with other glazing materials for glazing of glass; and (6) drying or setting-up time not required before sash or other material can be moved.

Preformed rubber sealants. Preformed gaskets of either natural or synthetic rubber, which have long had many uses in industry (notably in automobile manufacture), have in recent years begun to find application for sealing buildings. Neoprene is the material most widely employed for such preformed sealants;

it is tough and weather-resistant, and it has the mechanical properties needed for withstanding heavy structural loads.

A correctly designed rubber gasket maintains a tight seal despite the various types of movement that occurs between the building's sealed edges and surfaces. When an external force is applied against a gasket fitted into a confined space--as in sealing a light into a metal frame structure, for example--the rubber, under compression, conforms closely to the adjacent materials and effects a permanent water-tight, dust-tight, air-tight seal.

Relatively little preparation is needed for the installation of a preformed gasket. Absolute cleanliness of the adjacent members is not essential; and once the sealing operation is complete, there is little chance of dirt entering the joint. Also a correctly made and well-fitted gasket can be installed in almost any weather, often from the inside of the building.

Polysulfide based sealants. Polysulfide based glazing compounds (usually referred to by the trade name of Thiokol) are one or two-part thixotropic, polysulfide sealants, which cure at ambient temperatures to firm, flexible rubber. They have been specifically developed for glazing curtain-wall and window-wall structures where an absolute water-tight seal is required and where severe structural movement may be encountered.

Polysulfide glazing compounds have outstanding resistance to weathering, ozone, and solar radiation; and they provide excellent adhesion to glass, aluminum, stainless steel, and other architectural materials, even under the most severe weather conditions. The high adhesive strength of polysulfide glazing compounds is maintained even after long exposure to ultra-violet radiation, moisture, vibrational stresses, and extremes in temperature.

Polysulfide sealants are furnished in two forms: the one-part premixed sealant and the two-part sealant mixed on the job site. The advantage of two-part sealant is shorter curing (hardening) time, which is approximately seven days for the final cure at approximately 75° F. It has tack-free cure time of 24 to 72 hours at 75° F. This type of polysulfide sealant has a storage time (unmixed) of about one year. The basic part of the sealant is liquid polysulfide polymer (Thiokol) which is combined with an activator or curing agent of lead dioxide. The usual mixing ratio by weight is ten parts of base material to one part activator. Application time is the period of time that the sealant retains a workable consistency suitable for application with caulking gun, knife, or trowel. The length of time that the mixed compound remains workable depends upon temperature and humidity conditions. Low temperature and low humidity retard cure and increase working time, and high temperature and high humidity conditions accelerate cure and decrease working time. With approximate temperature of 75° F. and humidity of 50 percent, application time will be reduced from 2 to 6 hours, depending on the type of sealant used. For every 10° F. rise over 75° F., the application time is reduced by half; and for every 10° F. drop under 75° F., the application time is doubled. For mixing, the activator is added to the base compound, and the two should be mixed together immediately to avoid possible "spot curing." It is recommended that the activator be added to the base in small amounts and thoroughly mixed until all the

activator has been added. The compound should be slowly stirred with a flat paddle or a square-ended knife and thoroughly mixed approximately 7 to 10 minutes. The sides and bottom of the container should be scraped to include all the compound in the mixture and to ensure uniform blending. The mixing paddle should be scraped periodically to improve unmixed compound. Slow mixing by hand is recommended. When a mechanical mixer is used, it should not be operated above 300 rpm. High-speed mixing equipment may introduce air into the material and cause sponginess after aging or may raise the temperature within the mixture and shorten application life.

When it is desired to store sealants or premix at the job site, the sealant should be kept under refrigeration. Use of a quick-freeze technique is recommended so as to minimize the amount of application time that would be lost in a slower cooling procedure. One successful method is to immerse the filled cartridges for ten minutes in a slurry of dry ice and alcohol. The temperature of the sealant will drop to approximately -70° F., and the cartridges may then be transferred to a storage unit maintained at -20° F. Mixed sealants may be stored for 7 days at -20° F., or for 15 days at -65° F. The time consumed by freezing and thawing operations reduces the application time by approximately 30 minutes. Normally, "thaw time" is approximately one-half hour. After the sealant has been permitted to "thaw" or reach room temperature, the glazier can proceed to apply the material in the conventional manner. The sealant should not be overheated when thawing for use.

The one-part or factory-mixed polysulfide sealant has a longer curing time of about 10 to 20 days at 75° F. and a shorter storage time of about 4 months. Advantages of the one-part sealant are: (1) mixing is unnecessary since the material is ready to use as furnished; (2) longer time in the wet condition insures more positive adhesion; (3) air bubbles associated with mixing are eliminated; and (4) laboratory control insures consistent uniformity. All other characteristics of the two-part polysulfide sealant are approximately the same; the rest of the information in this section will pertain to both the one- and two-part polysulfide sealants.

As with all glazing compounds or sealants, the sealing effectiveness of a polysulfide compound is only as good as the quality of the surface preparation. The surface must be clean, dry, structurally sound, and free of loose materials, coatings, rust, oil, grease, paint, wax, silicones, weatherproofing, and release agents. New surfaces may be adequately cleaned with the use of a household cleanser and hot tap water. Surfaces should be washed thoroughly with hot water to remove all traces of cleanser and should be dried immediately with a clean rag or paper towel. When it is impractical to use cleanser, the surfaces may be cleaned with an oil-free solvent such as kylene, toluene, or methyl ethyl ketone. Surfaces cleaned with these cleaning agents should be wiped immediately with a dry clean cloth before the solvent has evaporated. Old surfaces having a coating of old oil-base caulking and glazing compounds, rust, or other products of corrosion must be thoroughly cleaned. Such cleaning can be done in most cases by scraping and sanding followed by solvent cleaning. However, in extreme cases, sandblasting or chemical cleaning may be necessary. Primer is not normally needed for nonporous material such as glass, metal, porcelain, and semiporous materials such as wood, marble,

concrete, and common brick. In some cases, the use of primers may be necessary to insure 100-percent adhesion. Deep cavities may be filled to within 1/2 to 3/4 inch of the surface with nonimpregnated jute, oakum, grout, preformed rubber, wood, and so forth before the sealing compound is applied.

Application of polysulfide sealant at temperatures below 40° F. is not recommended because of the possibility of the presence of condensation or frost, which may interfere with good adhesion. Some of the specific benefits and advantages of using a polysulfide sealant are the following:

1. Seals surfaces that are subject to extremes in movement, pressure, and temperature to provide an air-tight, water-tight, chemical-tight joint with a calculated life expectancy of more than 20 years

2. Remains flexible to form a joint that may expand and contract from 200 to 300 percent without breaking

3. Never shrinks after application, since it contains 99-percent minimum solids

4. Adheres without priming to almost any clean nonporous surface, such as glass, aluminum, steel, metals of all kinds, porcelain, and plastics

5. Has a service temperature range from -65° F. to 250° F.

6. Has excellent resistance to the elements and may be used under either interior or exterior exposures

7. Is economical to use since it prevents expensive maintenance

8. Can be applied best with a caulking gun, but application may be made with a putty knife

9. Can be used without heat either for application or curing

10. Resists water, sun, ozone, gasoline, oil, diluted acids, alkalines, and most solvents

11. Is available in a variety of colors

Health and safety precautions. The activator of polysulphide based compounds may contain lead, tin, zinc, and/or epoxy resins, depending on the particular type of selant used. These compounds may be irritating to the skin and eyes; therefore, direct contact with the material should be avoided. Any material on the skin should be removed promptly with suitable hand cleaner before eating or smoking. Inhalation of the vapors should be avoided. The material is combustible and is dangerous if taken internally. If the activator is taken internally by accident, a physician should be called immediately. It should be kept out of the reach of children.

Conventional Sealants

Although the modern sealants are finding wide acceptance in glazing, the conventional sealants--the putties and oil-based caulking compounds--remain important.

Wood sash putty. Wood sash putty or linseed oil putty, as it is sometimes referred to, is designed for glazing primed or unprimed wood sash and sash treated with water-repellant toxic solutions. Wood sash putty is generally made of a mixture of pure linseed oil, whiting pigments, and driers such as soy bean and perilla oil. Some wood sash putty contains basic carbonate of lead, or white lead, used generally where extreme hardness is desired on primed wood sash. Other types of wood sash putty contain a nondrying resin that prevents a stone-hard set.

A good grade of wood sash putty should not adhere with too great a tenacity to the putty knife or to the glazier's hands; yet, it should not be too dry for easy application to the sash. Application of a suitable primer, a priming paint, or boiled linseed oil to wood sash before applying putty is a necessary practice for good adhesion. If putty is too hard or stiff and has to be softened, pure linseed oil should be used as the softening or mixing agent; experience alone will tell the glazier what the right consistency is.

Putty should not be painted until it is thoroughly set. Too early painting forms an air-tight film, retarding drying and later perhaps causing the surface of the paint to crack. All wood putty should be painted at the correct time for proper protection of the putty surfaces.

Metal sash putty. Metal sash putty differs from wood putty by its being formulated to adhere to a nonporous surface. It is used in the glazing of aluminum, steel, stainless steel, bronze, and bonderized-galvanized steel sash. It is generally a mixture of pigment, vegetable oil, and volatile thinner.

If the metal sash putty is too hard or stiff to be used, the putty manufacturer's recommended thinner or white unleaded gasoline should be used as the mixing or thinning agent. At no time should any type of oil be used as a mixing agent. Oil mixed into metal sash putty will form pockets and cause the putty to bubble or wrinkle.

When glazing metal sash, the sash surfaces must be clean and dry. The sash must also be correctly installed and adjusted (racked) prior to glazing. The presence of grease, oil, dust from other construction activities, sand, mortar, water, frost, snow, condensation, rust flaking, incompletely dry paint, or other foreign or incompatible material will prevent satisfactory performance of the putty.

Under most conditions, metal sash putty will reach a firm set in about 14 days. A surface film will also have developed by this time, and the putty will not suffer damage from casual fingering at this stage. The putty will have good adhesion but may still be damaged if sash surfaces are handled carelessly. Full adhesion will develop within two to four months, depending on the job

conditions. If putty is to be painted, it may be painted at the finger-hard stage or later. Earlier painting will delay or prevent proper set.

Oil-based caulking compound. This compound is a ready-to-use oleoresinous (oil and resin) and elastomeric base of gun- or knife-grade caulking compound designed to seal joints where either similar or dissimilar building materials are joined. It is a uniform mixture of fibers, pigments, oils, and volatile solvents formulated to form a tough, durable skin, which will remain elastic and protect the body of the compound beneath this skin. The compound should stay soft, plastic, and tacky, adhering well to the surface on which it is applied.

All caulking installations should be made at temperatures above 40° F. Below this temperature, surfaces can become covered with condensation, which materially interferes with the bond. Further, at these low temperatures, the caulking compound stiffens so that the surface of the sash does not become sufficiently wet, resulting in further weakening of the bond.

If long lasting performance of a caulking compound is to be expected, it is important in any caulked joint that the depth be one to three times the width and that the joint be closed on three sides. If the depth is less than the width, it should be raked out to a greater depth. If the depth is more than three times the width, it should be partially filled with jute or oakum.

Before caulking compound is applied, all surfaces should be clean and dry. Masonry surfaces should be dusted with a stiff brush and blown clean to ensure the absence of dust. Metal and glass surfaces can be wiped down with mineral spirits or similar solvents, but should be thoroughly dry when the caulking compound is applied, since moisture interferes with adhesion. Priming is not necessary except on marble or granite. In all caulking installations, the surfaces should be smoothly tooled. The tooling not only provides an attractive smooth surface but, more important, presses the caulking compound firmly into place, increasing the adhesion to the sides of the joint. Caulking compound should always be used as received. If the consistency is too firm for proper working, the container may be placed in hot water for a short while. However, thinning or dilution should not be permitted. Oil-based caulking sealants should not be used for large lights of glass or as a metal-to-metal sealant where heavy movement from expansion and contraction will occur.

Study Assignment

1. Glazing Manual. Read pp. 7-10, "Glazing Materials."

2. Examine the sales literature and catalogs of the manufacturers of caulking compounds, putties, and sealants. These materials are available in the library.

UNIT F--MATERIALS

TOPIC 2--GLAZING SEALANTS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The newer types of caulking compounds employ __1__ in place of __2__ oils.	1. ______ 2. ______
2. Natural asphalt or coal tar __3__ very slowly, but it ultimately becomes __4__ and __5__.	3. ______ 4. ______ 5. ______
3. Adhesion is the __6__ by which one __7__ attaches itself to another.	6. ______ 7. ______
4. Elongation is the property that enables a material to __8__ without __9__.	8. ______ 9. ______
5. The __10__ strength of a material is the resistance it offers to being pulled apart.	10. ______
6. The bonding of sealants to surfaces is improved by the use of __11__.	11. ______
7. One disadvantage of silicone rubber sealants is that they are very __12__.	12. ______
8. Glazing tape is mostly used on __13__ __14__ in place of bedding putty.	13. ______ 14. ______
9. Butyl-based caulking compounds are __15__ __16__ systems, and thus require no __17__.	15. ______ 16. ______ 17. ______
10. The life of a seal made with a butyl-based compound can be expected to be as much as __18__ times that of one made with an oil-based material.	18. ______
11. Smeared butyl caulking material can be cleaned with __19__ solvents or __20__ spirits.	19. ______ 20. ______

12. Preformed __21__ __22__ are available for glazing-sealant applications.

21. ________
22. ________

13. Polysulfide sealant was specifically developed for glazing __23__ __24__ and __25__ __26__ structures.

23. ________
24. ________
25. ________
26. ________

14. The usual mixing ratio for two-part polysulfide sealant is __27__ parts by weight of base material to __28__ part(s) of activator.

27. ________
28. ________

15. Mixed two-part polysulfide sealant may be stored for 7 days at a temperature of __29__ or __30__ days at -65° F.

29. ________
30. ________

16. New surfaces can be prepared to take polysulfide sealant by cleaning them with __31__ __32__ and __33__ __34__.

31. ________
32. ________
33. ________
34. ________

17. If wood sash putty is too hard or stiff, it can be softened with __35__ __36__.

35. ________
36. ________

18. Under most conditions, metal sash putty will __37__ in about __38__ days.

37. ________
38. ________

19. If oil is mixed in metal sash putty, it will form __39__ and cause the putty to __40__ or __41__.

39. ________
40. ________
41. ________

20. All caulking should be done at temperatures above __42__ to ensure that condensation will not interfere with the __43__.

42. ________
43. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Metal sash putty is sometimes called linseed oil putty.	1.	T	F
2. Some wood sash putty contains white lead for extreme hardening.	2.	T	F
3. Unleaded white gasoline can be used in mixing metal sash putty.	3.	T	F
4. Adhesion is the force by which a material holds itself together.	4.	T	F
5. Oil-based caulking compound can be thinned with linseed oil.	5.	T	F
6. Oil-based caulking compound may be applied to a moist surface.	6.	T	F
7. One advantage of using glazing tape is that clean-up problems are eliminated.	7.	T	F
8. Good glazing tape will neither bleed nor stain finished surfaces.	8.	T	F
9. Butyl rubber caulking compounds are less expensive than polysulfide sealants.	9.	T	F
10. Elongation of butyl rubber caulking is about 200 percent, but return is only about 15 percent.	10.	T	F
11. Polysulfide sealant is manufactured only in pre-mixed form.	11.	T	F
12. Butyl-based sealants are nontoxic.	12.	T	F
13. After the two-part polysulfide sealant has been mixed, it cannot be stored.	13.	T	F
14. If polysulfide sealant is accidentally taken internally, a doctor should be called immediately.	14.	T	F
15. Low temperature retards the curing of polysulfide sealants.	15.	T	F
16. Absolute cleanliness is required in the installation of preformed rubber gaskets.	16.	T	F

17. Neoprene is the material most commonly used for preformed rubber gaskets. 17. T F

18. Silicone sealant cures by reaction with moisture in the air. 18. T F

19. Silicone sealants are available only in a neutral color. 19. T F

20. Silicone must be mixed on the job site. 20. T F

UNIT G Glass Processing

TOPIC 1--ECONOMY IN SELECTION AND CUTTING

This topic, "Economy in Selection and Cutting," is planned to help you find answers to the following questions:

- What rules apply in the economical selection and cutting of plate glass? Of window glass? Of rough rolled glass?
- How are stock sizes of plate glass bracketed?
- How are "united inch" classifications employed to bracket stock sheets of window glass?

The profits of a glass business are affected greatly by the amount of waste involved in the cutting process. Almost all of the glass used must be cut from stock sheets supplied from the factories. Skillful selection of stock sheets from which the smaller sizes are to be cut is the mark of a good journeyman.

Different rules apply in selecting and cutting the three general types of flat glass: plate glass, window glass, and rough rolled glass. Plate glass and window glass are bought and sold in sheets of various classifications, or "brackets," which indicate size ranges. Bracket classifications and their values vary from area to area and between different levels of the trade. Rough rolled glass is bought and sold in increments of square feet.

Plate Glass

In order to determine the value of a given light of plate glass, the glazier must first establish the total area, in square feet, of the light. He must then multiply this total square-foot area by the value per square foot of the glass. Because of the wide variation in sizes of plate glass, a means of deciding what square-foot value to apply is needed. As a general rule, as the size of the glass increases, the value per square foot increases. This is caused by various factors, among which are increased cost of handling, risk of breakage, cost of storage, and cost of manufacture. For example, four lights of plate glass 36 in. x 60 in. have a total combined area of 60 sq. ft., and one light 60 in. x 144 in. also has an area of 60 sq. ft. However, even though the same number of square feet is involved in both instances, the four smaller lights of glass have less total value than the one large light of glass, because the value per square foot of area is less for the smaller lights than for the large light.

To simplify this problem, therefore, stock sheets of plate glass are valued according to "brackets." These are classifications that describe a range of square feet within which the price per square foot is the same. If, for example,

a stock sheet of plate glass contains more than 10 sq. ft. but less than 15 sq. ft., it is classified as being in the "10 to 15" bracket. If it contains more than 15 sq. ft. but less than 25 sq. ft., it is classified in the "15 to 25" bracket. Each bracket has its own cost per square foot. Although values and ranges of square feet may vary, the general pattern of groupings of the more commonly used sizes is about as follows:

Less than 5	15 to 25
5 to 10	25 to 50
10 to 15	50 to 75

When a light of glass is to be cut to a particular size, it is wise to choose a stock sheet that is within the same size bracket as the piece required. The value of the stock sheet and the piece to be cut will then be the same per square foot. A minimum of waste should be trimmed from the stock sheet, of course, since waste glass was paid for when the stock sheet was purchased and will therefore affect the profit on the light being cut.

Window Glass

Window glass is bought and sold in stock sheets classified in brackets of another type, which are determined by the "united inch," the sum of any two sides of a piece of glass that form a 90° angle. For example, a light of glass has one 12-inch side and one 24-inch side: the sum of the lengths of these two sides is 36 inches, which is the united-inch size of that light of glass. When a united-inch size has been determined, it is then checked against the bracket values to determine the value of the piece of glass. For example, all lights with a united-inch size up to and including 40 inches are valued in the 40-inch bracket, and all lights having a united inch size of from 41 inches to and including 50 inches are valued in the 50-inch bracket. As the number of inches specified by the bracket increases, so does the value per inch. Therefore, when stock sheets of window glass are being selected for cutting to smaller sizes, care should be taken to cut from lights that fall into the same bracket as the piece desired.

Rough Rolled Glass

Stock sheets of rough rolled glass supplied from the factory vary in width from 18 in. to 60 in. and in length from 120 in. to 144 in. The combination of width and length varies according to the pattern of the glass. Other widths and lengths are available in some special instances. The value per square foot does not increase as the size of the glass increases. When cutting this type of glass, the important factor to consider is waste. Careful selection will keep waste losses to a minimum.

Topic for Discussion

Be prepared to discuss the factors that could influence the selection of glass for cutting if you are asked to do so.

UNIT G--GLASS PROCESSING

TOPIC 1--ECONOMY IN SELECTION AND CUTTING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The term "bracket," as it is used in connection with __1__ glass and __2__ glass, means a __3__ range. — 1. _____ 2. _____ 3. _____

2. The most important consideration in deciding what size stock sheet to cut to obtain a particular size of glass is __4__. — 4. _____

3. The value per square foot of a piece of plate glass is in part determined by the __5__ of the light from which it is obtained. — 5. _____

4. Stock sheets of window glass are classified according to __6__ __7__ size brackets. — 6. _____ 7. _____

5. A bracket described as "15 to 25" could be used in determining the value of __8__ glass. — 8. _____

6. A light of window glass 16 in. x 20 in. could be cut most economically from a sheet in the __9__ bracket. — 9. _____

7. A type of glass whose cost per square foot does not vary with the size of the light is __10__ __11__ glass. — 10. _____ 11. _____

8. A light of store-front plate glass 48 in. x 120 in. would fall into the __12__ bracket. — 12. _____

9. Among the factors that make for the higher cost per unit of area of glass in the larger size brackets are the increased risk of __13__ and the increased costs of __14__, __15__, and __16__. — 13. _____ 14. _____ 15. _____ 16. _____

10. The profits of a glass business are reduced by cutting which involves too much __17__. — 17. _____

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	All flat glass is priced according to size brackets.	1.	T	F
2.	Bracket classifications vary from area to area.	2.	T	F
3.	Rough rolled glass is sold in increments of united inches.	3.	T	F
4.	When a light of glass is to be cut to a particular size, a stock sheet should be chosen that is within the same size bracket as the piece required.	4.	T	F
5.	Plate-glass size brackets are based on united feet.	5.	T	F
6.	Each size bracket for plate glass of a given specification has its corresponding cost per square foot.	6.	T	F
7	The value per square foot of rough rolled glass is not related to the size of the light.	7.	T	F
8.	The united-inch size of a piece of window glass is the product of the lengths of any two sides that form a 90° angle.	8.	T	F
9.	A piece of window glass 18 in. by 24 in. should be cut from a sheet in the 50-in. bracket.	9.	T	F
10.	Stock sheets of rough rolled glass are available in 60-in. widths.	10.	T	F

UNIT G--GLASS PROCESSING

TOPIC 2--CUTTING

This topic, "Cutting," is planned to help you find answers to the following questions:

- What preparations must be made before the cutting of glass is attempted?
- What techniques are employed for making cuts of various types in glass?
- What special precautions must be observed in cutting mirrors and laminated glass?

Correct Procedure for Cutting Glass

A glazier can develop skill in the art of cutting glass only by a great amount of practice and close observation to detail. Although the cutting of glass may appear to be simple, a closer analysis of the process reveals that many factors are involved.

Preparing to make the cut. Before a cut is traced, the surface of the glass must always be wiped clean and free from water and dust. With heavy glass over 1/4 in. thick, including structural glass, a cloth or a finger cot soaked in a lubricant is drawn along the proposed path of the cut. Before making any cuts, the glazier should make certain that the cutting wheel is free of imperfections and is reasonably sharp and well lubricated. It is advisable to make a trial cut on waste material An experienced glazier knows the condition of the wheel of the cutter by the sound it makes when cutting and by observing the cut. There should be no nicks or gaps in the wheel. It should run free and should not wobble on its axle. Nicks on the edge of the wheel or binding of the wheel on its axle can cause skips that in turn prevent the cut from running true, resulting in a waste of glass. Cutting should always be done in a normally warm room, preferably at about 60° to 70° F. No cut should be made on glass at temperatures above 110° F.

Holding the cutter. The way in which the craftsman holds the cutter is of primary importance in successful glass cutting. The index finger should rest on the curved shoulder on the front of the cutter. As the cut is made, the tool may incline slightly toward the operator. The degree of this angle is not critical and will vary according to the individual. However, the cutter should not lean to one side or the other in relation to the cut; the wheel must be perpendicular to the glass surface.

Applying pressure. The second consideration in the proper cutting of glass is the amount of pressure to be used when a cutter is drawn across a piece of glass. Only by practice and careful study can a glazier acquire the knack of applying the proper pressure. The sound of the wheel moving over the glass varies with pressure, and the glazier learns to gauge the amount of pressure

to use by the sound. With practice, he will be able to tell when a correct "cut" is made and also when the glass is merely scratched.

After the mark is made, pressure is applied to break the glass; the pressure to be used varies with the thickness of the glass. The depth of penetration of the cutter also varies with glass thickness.

The glazier should never try to retrace a cut. Retracing will only roughen the edges of the first cut and may cause the cut to jump (or run). If the original cut is not satisfactory, the straightedge should be moved a fraction of an inch outside of the intended line of cut and a new cut made.

Straight cuts. If a table is used for cutting glass, it should be as flat as possible and free of dirt and cutting debris, since glass has a tendency to break incorrectly when any surface tension or strain is present. If glass is cut in a vertical position, as is often the case in field work, care should be taken to ensure that the glass is not twisted or bent, as such conditions also cause the glass to break improperly.

The size of the light of glass being cut will determine the proper method of running the cut. When glass is being cut on a table, one of the three following methods may be used to run the cut:

1. (Method used when there is approximately the same amount of glass on each side of the cut.) Position the glass with a straightedge directly underneath the cut. Apply pressure to the glass on both sides of the cut.

2. (Method used when only a small amount of glass, perhaps 1 or 2 in., are to be removed from a large piece.) Place the glass so that the waste edge extends slightly over the edge of the table. Using glass pliers, exert sufficient steady downward pressure to cause the run. (In some cases, the glass may be tapped lightly from the under side to start the run.)

3. (Method suggested for use when the light of glass is small enough for one man to handle and when the area to be cut off is too wide for the use of method No. 2, yet not large enough for method No. 1.) After the cut is made, extend the waste portion of the glass over the edge of the table until the cut is in line with the edge of the table. Then lift the waste side of the glass slightly and drop it. (The height to which the glass must be lifted depends upon the thickness of the glass.)

When vertical cuts are made on the job, the following rules should be observed:

1. Do not attempt to remove more than 2 to 4 in. of waste at one time. If more must be removed, repeat the cutting procedure. This is referred to as "stripping."

2. Be certain that the glass is standing free and that no undue strain or twist is present.

3. Do not attempt to cut glass that has been allowed to stand in the sun for any great length of time; thermal strain caused by this exposure will often cause the cut to fail.

Circles and outside curves. The cutting of circles or curves requires procedures different from those followed for making straight cuts. After the cut has been made, the light of glass should be turned over and laid flat on the table, and pressure should be applied directly over the cut. This pressure should be moved around the cut, following the run.

In most cases, the waste glass cannot be removed in one piece. The method used to remove the waste glass (selvage) from circular or curved cuts varies, depending upon the size, thickness, and shape of the glass. Removing this selvage a small piece at a time is the generally accepted procedure, which may be facilitated by making straight cuts from the edge of the waste to the circular cut. Each straight cut should be made tangent to the circular cut. This method will minimize the chance of chipping the edge of the work.

Incuts. For making incuts that have shapes other than circular, the same procedure should be followed as for circles and outside curves, except that the waste area must be removed in a different way. One method is to cut, run, and remove triangular pieces of glass from the waste area, one after the other. The size of these pieces may vary, depending upon the size of the waste area involved, but in all cases one point of the triangle should terminate at the original cut. The points are usually started by drilling.

Holes. Although round holes are most frequently cut with a tube drill, they may also be cut by the same general procedures described for cutting circles and outside curves. A suggested method for removing the waste material from a hole is to drill four small holes connecting with the original cut at four equally spaced points, as shown in Fig. G-1. Cut and run a square connecting these four points. Then cut and run diagonals in the square. After these cuts have been made, the selvage glass may be tapped out.

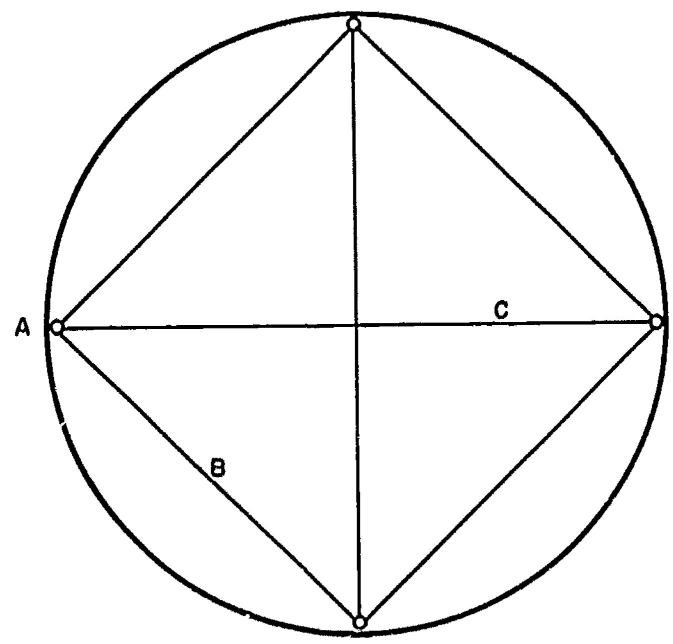


Fig. G-1.
Removing waste material to make a hole:
A—drilled holes; B—square; C—diagonal

Laminated glass. The same requirements for cutting the types of glass already discussed in this topic are applicable to the cutting of laminated glass. However, several additional requirements must be met. Laminated glass should not be cut at a room temperature below 70° F. or above 110° F. if satisfactory results are to be achieved. A cut should be made on one face of the glass and should immediately be run carefully, with the least possible amount of bending. The glass should then be turned over and another cut made and run directly above the cut on the opposite face. Although both pieces of glass in the laminated piece will now have been cut, the plastic sheet between will not have been severed. Special care must be employed at this point; the chief cause of glass breakage is chipping during the cutting of the plastic and the removal of the waste glass.

Three different methods may be used to sever the plastic: the hot-wire method, the cold method, and the solvent method. The hot-wire method was once used almost universally on exacting work, but it is now becoming obsolete.

In the hot-wire method, the glass should be blocked up about 2 in. above an asbestos-covered table with felt-covered blocks, and the wire should be placed in the cut about 1/16 to 3/16 in. toward the waste side. The hot wire will soften the plastic in a few minutes, and the waste piece of glass can then be pulled away horizontally far enough to permit the plastic to be cut with a razor blade without causing chips on the good side of the cut.

The cold method of cutting the plastic requires glass pliers and a razor blade. The glass should be clamped securely to a table top with the waste portion overhanging the edge of the table. Gripped with one hand, the pliers pull the cut apart and stretch the plastic sufficiently to allow a razor blade, held in the other hand, to cut the plastic. The waste piece should not be allowed to bend up or down, as chips in the glass may result. Stretching and cutting the plastic can be facilitated by immersing the entire sheet of glass for a few minutes in a vat of water heated to a temperature of 160° to 170° F. Then the waste can be removed easily with the pliers and the razor blade. No edgework on glass should be done until the glass has been cooled to room temperature.

The third method of severing the plastic--the solvent method--is by far the easiest and is becoming the most widely used. The appropriate solvent for the plastic is squirted on the cut, which can then be broken out almost immediately.

Mirrors. When mirrors of various sizes are cut from stock sheets, these sheets must be handled even more carefully than fine plate glass. Special care must be used in laying mirrors on the cutting table. When large stock sheets are to be cut, a tilting cutting table is most desirable. The table should be tilted to the upright position and the mirror set up flat against the table. This procedure eliminates sliding the sheet onto the table, which is likely to scratch the back of the mirror. However, smaller lights may be laid down onto the table by one or two men, although here again great care must be taken to see that the glass does not slide on the table. Any dirt or debris trapped between the mirror and the table may scratch the back of the mirror. One method of preventing this whenever glass is moved is to raise the mirror from one side so that the back does not come into contact with the table surface.

UNIT G--GLASS PROCESSING

TOPIC 2--CUTTING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The cutting wheel must always be perpendicular to the __1__; the cutter may be inclined slightly toward the __2__.	1. ______ 2. ______
2. An experienced glazier judges the proper amount of pressure to apply in cutting by the __3__ of the cutter.	3. ______
3. The amount of penetration needed in a cut may vary with the __4__ of the glass.	4. ______
4. Retracing a cut will invariably __5__ the edges of the first cut.	5. ______
5. It is important for any cutting table to be __6__ and free of __7__ because glass may break incorrectly when it is subject to __8__.	6. ______ 7. ______ 8. ______
6. When the glass is cut vertically, the mechanic must be sure it is not __9__ or __10__; only small pieces should be removed at a time, a process called __11__.	9. ______ 10. ______ 11. ______
7. Whenever a large light of glass is cut approximately in half, a(n) __12__ is placed under the cut.	12. ______
8. When a cut is run by placing the waste edge over the edge of the table, the cut may be tapped from the __13__ side.	13. ______
9. The cuts in the waste pieces of a circular cut should be __14__ to the circular cut; this minimizes the likelihood of __15__.	14. ______ 15. ______
10. The waste glass may be removed from incuts by cutting it into __16__ pieces, then __17__ and removing the pieces.	16. ______ 17. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The chief problem in cutting laminated glass is to cut the plastic and remove the waste without separating the laminated sheets. — 1. T F
2. Lubricant should be used between the cutter wheel and the surface of heavy glass. — 2. T F
3. Nicks on the edge of the cutter wheel will prevent it from running true. — 3. T F
4. To ensure an adequately deep cut, the glazier should retrace the cut on heavy plate glass. — 4. T F
5. Glass will not break correctly if it is cut while under stress. — 5. T F
6. Small waste pieces from straight cuts can best be removed with glass pliers. — 6. T F
7. Stripping is a technique of removing waste glass from circular cuts made at the job site. — 7. T F
8. Glass selvage is usually removed in small pieces when a circular piece is being cut. — 8. T F
9. Large mirrors must be cut in the horizontal position. — 9. T F
10. The condition of a cutter wheel is best verified by making a trial cut on waste material. — 10. T F

UNIT G--GLASS PROCESSING

TOPIC 3--EDGEWORK

This topic, "Edgework," is planned to help you find answers to the following questions:

- What types of edgework are performed in the glazing shop?
- How do the various types of glass edges differ in appearance, and how is each type produced in the shop?
- What precautions must be observed if quality edgework is to be done?

Types of Edgework

A glazier is often required to work in the shop. Edgework, one of the many jobs done in the shop, includes the finishing of the exposed edges of such items as mirrors, table tops, and auto glass. This topic deals with the various types of edgework that must be done by the craftsman in the glazing trade.

Clean-cut edge. When glass is cut, a clean-cut edge usually results if the cut is made correctly with a good cutter (Fig. G-2). The edge and the flat surface of the glass should meet at 90°, and the edge should be reasonably free of spalls, flares, and chips.

Swiped edge. The purpose of the swiped edge is to relieve the sharpness that is characteristic of the clean-cut edge. This operation is done in several different ways, including using a hand stone, a grinder, an upright abrasive belt sander, or a portable abrasive belt sander. The tools most commonly used are the sanders. The glass is placed so that it meets the belt at approximately a 45° angle, and the sharp corners of the clean-cut edge are thus ground away. Since a rough belt is generally used, this procedure is done very quickly so that not too much glass will be ground away. Nothing is done to the flat surface of the edge; this remains as it is on a clean-cut edge (Fig. G-3). The most common use of the swiped edge is in work on mirrors to be installed with metal frames. Here the swiped edge serves to minimize the possibility that the edge might chip as the mirror is slipped into the close-fitting frame. In a variation of the swiped edge, the flat surface may also be ground. This is called a flat-ground edge.

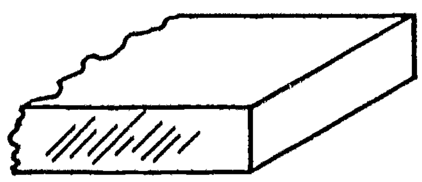


Fig. G-2. Clean-cut edge

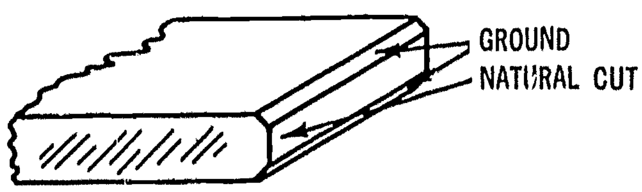


Fig. G-3. Swiped edge

Seamed edge. The seamed edge is similar to the swiped edge but is used more widely, since it is generally considered to be a more finished product (Fig. G-4). The seamed edge is used when a finish is desired on the exposed edge; greater care must therefore be exercised during its processing. Either a flat stone or a fine smoothing belt is used to produce this edge. Except that the belt or stone employed is less coarse, the procedure is similar to that used to produce the swiped edge. A good seamed edge will appear to be semi-polished. A common application of this type of edge is on table tops.

In some cases, a seamed edge may be polished instead of merely smoothed; such an edge is referred to as a polished seam.

Flat polished edge. The procedure used for producing a flat polished edge is similar to that used for making the seamed edge, except that the flat edge is also polished (Fig. G-5). This, therefore, is an even more refined edge. It is used for such work as showcases, shelves, and mirrors. Sometimes when glass is cut, small dimples, flares, or flaws occur in the flat edge. As the seaming process does not eliminate these imperfections, a flat polish is desirable for improved appearance of the edge.

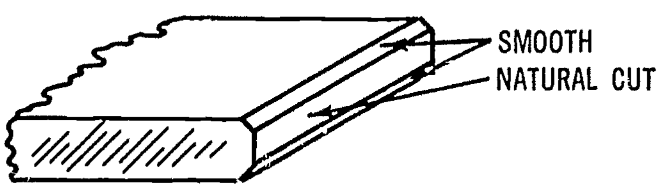


Fig. G-4. Seamed edge

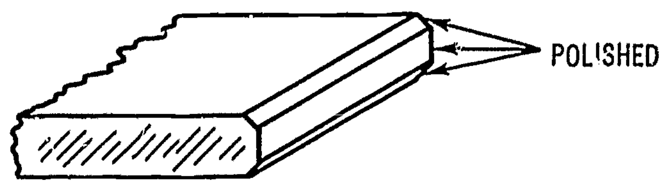


Fig. G-5. Flat polished edge

The belt or stone used to fabricate the flat polished edge may be the same as that used for the seamed edge. However, an abrasive of a finer grit may be more desirable. The flat polished edge is produced by the following five steps:

1. Rough grind--The edge of the glass is placed at an angle of 90° to the grinder; this may be a flat steel wheel upon which a mixture of either carborundum and water or aluminum oxide and water is allowed to flow, or it may be a wet belt machine. This process will flatten the edge and eliminate all irregularities.

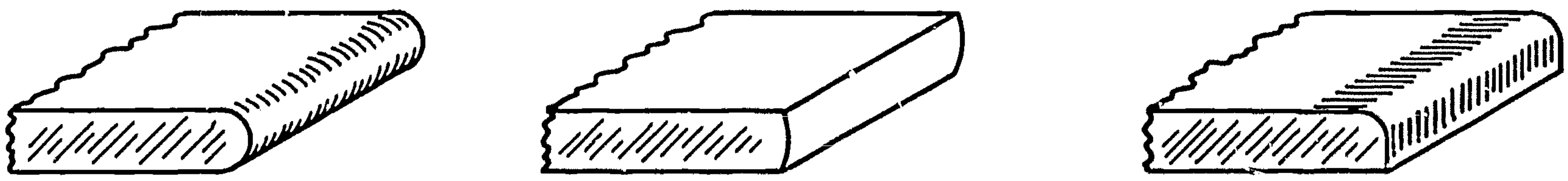
2. Smooth--The edge of the glass is placed at 90° to the smoothing wheel or fine belt. This will smooth out the rough ground edge and produce a smooth, dull finish.

3. Seam--This is done in the manner prescribed for the seamed edge.

4. Cork polish--The edge of the glass is brushed back and forth lightly against a cork wheel or belt. The wheel or belt is kept saturated throughout the operation with a mixture of fine pumice stone and water. The wheel or belt should not be allowed to dry out, as friction will cause burning, which results in a spalled edge; if this occurs, the entire process must be done over. After several strokes, the glass edge will become milky white, and the glazier may proceed to the next step.

5. Rouge polish--The edge of the glass is brushed lightly against a felt wheel impregnated with a jeweler's rouge and water. This process eliminates the milky white cast left by the cork polisher. A very high or glossy shine similar to the flat surface of the glass will be produced in a short time. Again, caution should be used to keep the wheel from drying out. If the glass burns, the entire process fails and must be done over.

Variations of the flat polished edge. The round polished, pencil polished, and bullnose polished edges are all variations of the flat polished edge (Fig. G-6). The same basic procedures apply except that the seaming and polishing are done in one operation by means of a slightly different type of machine. The most satisfactory machine employs an upright abrasive wheel. The edge of the wheel is grooved to fit these various edges. Although the wheel is made of a very fine abrasive, the initial step of rough grinding may be eliminated in most cases. However, if the edge is rough, preliminary rough grinding is advisable; if this precaution is not taken in such a case, the rough edge of the glass may tear up the wheel.



Round polished edge *Semiround or pencil polished edge* *Bullnose polished edge*

Fig. G-6. Variations of flat polished edge

Beveled edge. The beveled edge is widely used in mirror work. This edge is formed by grinding away a part of the top surface of the glass and then repolishing this area to match the finish of the flat surface of the glass (Fig. G-7). Almost all beveling today is done by machine; the glass is set in a jig to the desired angle and is finished by an automatic process. However, a knowledge of the basic processes can be helpful to the glazier in emergencies when a beveled edge must be made and automatic machinery is not at hand.

The process used for producing a beveled edge is similar to that used for a flat polished edge. The angle of a beveled edge varies according to the width of bevel desired; the width is measured on the flat surface, in from the edge. The glass is held to the wheel at an angle that will allow for the required bevel and a sufficient flat surface. It is moved across the grinding wheel until the proper amount of glass (typically 1/2 in.) is ground away. After the rough grinding has been done, the edge is polished, following the procedures outlined for flat polishing.

Mitered edge. A mitered edge is ground to a single continuous angle with the flat surface of the glass (Fig. G-8). This type of edge is used most frequently in cases where two pieces of glass meet at an angle other than 180°, either in a store front or a showcase. If the edge of each light is ground to one-half the angle of the joint, the two pieces can be butted together and cemented to form a continuous unbroken line of glass. This eliminates the use of corner bars, which is desirable in some types of work. An example of the use of such an

edge is the installation of two pieces of plate glass to form a 90° corner. The edge of each light is ground away to an angle of 45°, and the two lights are joined to form a 90° corner. When the miter is ground back under the face of the glass, it is called a back miter; otherwise, it is a face miter. The edge of the glass is ground but not polished; this permits the cement used to join the two pieces together to make a much better bond with the glass, and a firmer joint results.

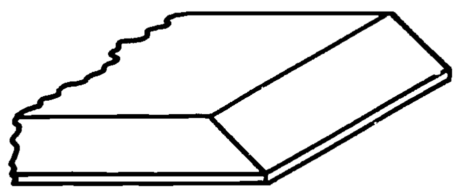


Fig. G-7. Beveled edge (all edges polished)

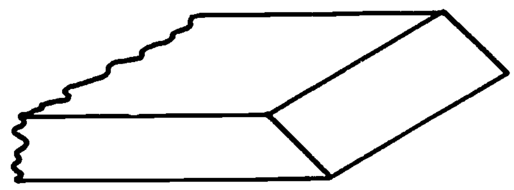


Fig. G-8. Mitered edge (ground)

Quirk miter. In a quirk miter joint, the points are cut off the two mitered edges to be joined so that the edges resemble beveled edges (Fig. G-9). However, in a quirk miter the bevel is ground and the flat edge is polished; the bevel makes the joint, and the flat edge is exposed. Because the glass is not ground to a feather edge, this joint is less subject to spall than a regular miter joint.

When a miter joint is in an inside corner, the joint is referred to as a reverse miter; a quirk miter cannot be used in such a case, since the polished edges cannot be seen effectively from the front of the glass or mirror surface.

Decorative edges. The V-groove motif obtained from the two exposed square polished edges in a quirk miter is highly decorative and is often used in mirror work, sometimes on the vertical edges of mirrored pilasters. The best angle with the flat surface for such an edge is 90°. As the angle increases, the polished edges become less effective.

When a thin piece of glass is joined to a thicker piece below it, a polished seam or small bevel may be applied to the exposed edge of the thicker piece, as in Fig. G-10. The result is a very decorative effect, which may be used for the bases of bulkheads and plinth blocks on door or window casings.

Special precautions for edging mirrors. Although most mirror edging is done on automatic machines, in smaller shops it may be done by hand, either with portable abrasive machines or stationary machines. It is easy to damage a mirror during this process, but several things can be done to minimize the damage.

Since the portable abrasive belt machine is operated without a coolant, there is an ever-present danger of overheating the glass. This danger is especially critical in edgework with mirrors, since the film of silver and the protective coating on the back of a mirror may flake off if they become overheated, as a result of friction between the belt and the glass. The use of the following procedures will prevent overheating the work:

1. Use only slight pressure against the glass.
2. Use a continuous back and forth motion along the edge of the glass.
3. Do not allow the machine to stop in any one place, as this may cause excess heat to build up.

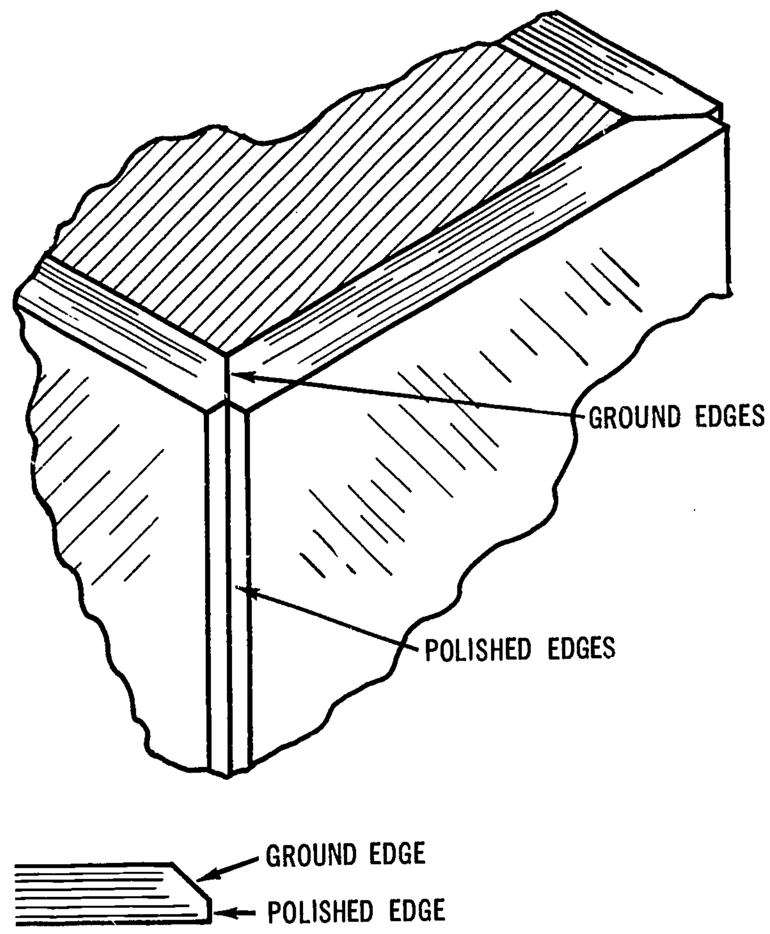


Fig. G-9. Quirk miter

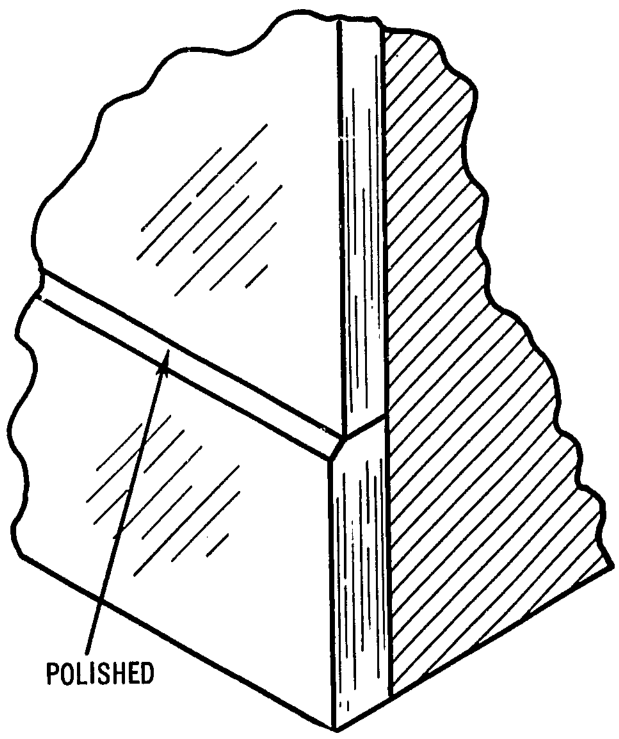


Fig. G-10. Polished bulkhead edge

Although a water coolant is used with the stationary machine to minimize the danger of heat damage, other hazards are present when this type of machine is being used. When an edge is processed on an upright belt machine, for example, the glass is often laid down flat on a movable table, and the table is then moved along in front of the machine as the edge is processed. The vibration of the machine can cause the surface of the glass that is resting against the table to be damaged if any debris becomes trapped between the glass and the table.

As the process of finishing the edge of a mirror often involves the use of water, small flakes, chips, or particles of abrasive may be trapped in the excess water on the glass. Special care should be taken in removing this excess water to prevent scratching the glass.

A number of other machines may be used to process the edges of mirrors. If the precautions given above are observed in all cases, no damage should occur.

UNIT G--GLASS PROCESSING

TOPIC 3--EDGEWORK - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: In the numbered blank to the right of each statement below, write the name of the type of edge described in that statement.

1. Edge and flat surface meeting at 90°	1. ____________
2. Edge polished in three planes	2. ____________
3. Edge polished to a half circle	3. ____________
4. Top part of edge ground away at a large angle with the flat surface and polished	4. ____________
5. Edges in three planes, two of which are smoothed	5. ____________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	A seamed edge is used for table tops.	1.	T	F
2.	A quirk miter is more fragile than a face miter.	2.	T	F
3.	A seamed edge has a better finish than a swiped edge.	3.	T	F
4.	A pencil polished edge may also be called a round edge.	4.	T	F
5.	A clean-cut edge is unfinished.	5.	T	F
6.	A back miter undercuts the face of the glass.	6.	T	F
7.	Only the flat edge of a quirk miter is polished.	7.	T	F
8.	A mitered edge is ground rather than polished primarily because it will not be exposed to view.	8.	T	F
9.	All planes of a beveled edge are polished.	9.	T	F
10.	The rough-grinding step ordinarily may be skipped during the flat-polishing process.	10.	T	F
11.	The final polishing of a flat-polished surface is done with jeweler's rouge.	11.	T	F
12.	A grooved abrasive wheel is used to produce a beveled edge.	12.	T	F
13.	The width of a bevel is measured on the flat surface, in from the edge.	13.	T	F
14.	In a miter joint, each piece of glass is ground down to an angle equal to the angle of the joint.	14.	T	F
15.	Special precautions to prevent overheating must be observed in doing edgework on mirrors in the shop.	15.	T	F

UNIT G--GLASS PROCESSING

TOPIC 4--FABRICATION

This topic, "Fabrication," is planned to help you find answers to the following questions:

- What does the term "fabrication" mean as it is applied in the glazing trade?
- How do hand drilling and machine drilling methods differ in the fabrication of glass, and what tools and equipment are used in each method?
- How are notches cut in glass?

The glazier is often required to drill holes and cut notches in glass. The general rules and procedures governing this general classification of work, which is called fabrication, will be discussed in this topic.

Drilling Holes

Because of the variety of hole sizes and glass thicknesses involved, many different tools and procedures are required for drilling holes. However, two basic methods will apply in most instances--hand drilling and machine drilling. Cutting notches usually involves first drilling holes, then cutting, but this process may also be done by automatic machines.

Hand drilling holes. For drilling holes from 1/8 in. to 1/2 in. in diameter in glass, a hard carbide or tungsten-steel tipped drill bit is most often used. Several types of drill bits are available for this work; however, the type of bit employed is not as important as the use of the correct procedure. Any one of the appropriate drill bits will do the job very well if the procedure described below is followed:

1. Place the glass on a clean, flat, padded table. Be certain that the glass is supported firmly under the entire area. The glass must not be twisted, as twisting sets up undue surface tension that may cause the glass to break during drilling.

2. Select a drill bit of the proper size. Insert it in a brace or portable electric drill. Press the point of the drill bit against the glass, and with a very light pressure, twist the drill bit one-half turn back and forth. Repeat this procedure until a mark is made in the glass. (If a portable electric drill motor is being used, do not attempt to use power until the starting mark has been made in the glass.) Unless this mark is made, there is a possibility that the drill point will slip.

3. Lubricate the drill bit and the area of the hole. Turpentine is recommended for this purpose. Keep the drill bit and general area of the hole well lubricated during the entire drilling process. This will minimize the heat from

the friction between drill bit and glass, which can cause breakage if it becomes excessive.

4. After the starting mark has been made, complete the drilling. Employing a steady, continuous, counterclockwise motion with gentle pressure, turn the drill bit until it penetrates approximately halfway through the glass. Turn the glass over and repeat the entire process. The drilling should be done from each side to the half-way point in order to prevent the drill bit from breaking through the surface and chipping the glass around the hole. CAUTION: If a drill motor is used, it must be geared to a low speed that is as close as possible to the speed used in the hand process. If the drill speed is too high, friction between the drill bit and the glass will cause excessive heat that may result in damage to the drill bit, breaking of the glass, or both.

5. Goggles should be worn as a protection against flakes and chips of glass.

Machine drilling holes. For holes of from 1/2 in. to 6 in. in diameter, a drill press with cylindrical metal abrasive bits--tube drills, as described in Unit E--is recommended. This type of drilling should not be attempted free-hand, as the slightest variance in the vertical position of the drill may cause the bit to bind and break the glass. Low speeds are used, but in most cases speeds may be slightly higher than those employed for hand drilling. The procedure for machine drilling holes is as follows:

1. Place the glass in position under the drill head. The glass should lie flat and be free of tension or twist.

2. Select the proper tube drill, and insert and tighten it in the chuck, making sure that it runs true.

3. With putty or some other waterproof pliable material, construct a circular dam slightly larger in diameter than the hole to be drilled. This dam should be about 1 in. high.

4. Fill this dam with a mixture of abrasive and water. Carborundum or aluminum oxide are good abrasives for this purpose. The use of water with the abrasive will minimize the heat buildup caused by the friction between drill bit and glass, which could break the glass should it become excessive.

5. Start the drilling machine. With light pressure, allow the drill bit to come in contact with the surface of the glass. The success of this type of drilling process depends on the wearing effect of the abrasive between the edge of the tube drill and the glass. Therefore, it is necessary to decrease the pressure on the drill frequently to allow fresh abrasive to flow under the drill edge, then reapply pressure. This alternation should be repeated as often as is necessary throughout the operation until the drill bit has worn its way through the glass.

Cutting Notches

When notches are to be cut in glass by hand, the following procedure is used:

1. Place the glass on a clean, flat, padded surface.
2. Lay out the pattern of the notch with a grease pencil on the surface of the glass.
3. Drill a 1/4-in. hole at each of the two points where the lines of the pattern intersect, as shown in Fig. G-11.
4. With a glass cutter, mark between the two holes and between the holes and the edge of the glass.
5. Turn the glass over and run the marks.
6. Carefully remove the waste glass from the notch. Make any secondary cuts in the waste glass that may be required to relieve the tension and to remove the waste glass without undue chipping of the finished cut.

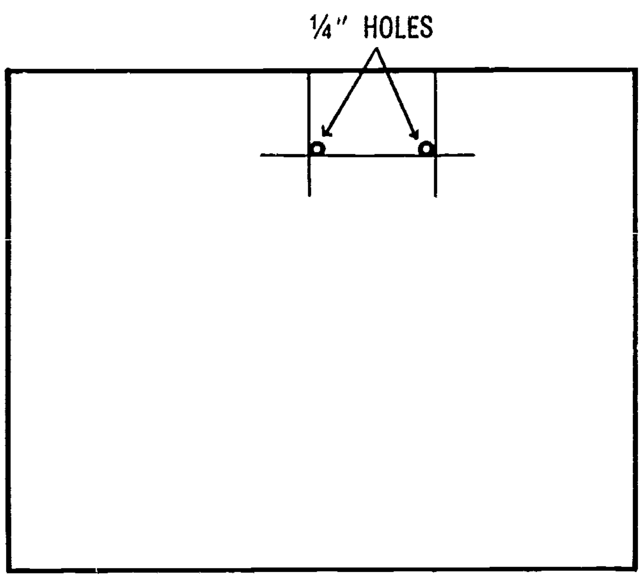


Fig. G-11. Cutting a notch

UNIT G--GLASS PROCESSING

TOPIC 4--FABRICATION - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The most important factor in the hand drilling of holes in glass is the __1__ used. — 1. ______

2. Drill bits used for hand drilling are usually __2__ or __3__ steel tipped. — 2. ______ 3. ______

3. A mark is made before drilling is started in order to prevent the drill __4__ from __5__. — 4. ______ 5. ______

4. Tube drills use an __6__ and __7__ mixture to accomplish the actual drilling away of the glass. — 6. ______ 7. ______

5. In hand drilling, the hole should be drilled from __8__ side(s) of the glass; the purpose of this procedure is to prevent __9__ of the glass. — 8. ______ 9. ______

6. In hand drilling, the recommended lubricant is __10__. — 10. ______

7. The wearing of __11__ is an important safety precaution in drilling glass. — 11. ______

8. If the machine method rather than the hand method is used to drill a hole in glass, a slightly __12__ drill speed can usually be employed. — 12. ______

9. Glass drilling with tube drills should not be attempted __13__ because such drills can work safely only if they are operated in an exactly __14__ position. — 13. ______ 14. ______

10. A(n) __15__ must be constructed around the proposed hole when glass drilling is to be done with an abrasive bit. — 15. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. A low-speed portable electric drill can be used for drilling holes up to 1/2 in. in diameter in glass.	1.	T	F
2. Light pressure must be employed in any glass-drilling operation.	2.	T	F
3. Water is an acceptable lubricant for hand drilling in glass.	3.	T	F
4. In drilling glass by hand method, the drill bit should be turned counterclockwise.	4.	T	F
5. Dry abrasive is used for drilling thick glass.	5.	T	F
6. The dam required in machine drilling should be about 1 in. high.	6.	T	F
7. The speeds at which glass drilling is done are too low to present any serious safety hazard to the operator.	7.	T	F
8. Holes in the range of diameters from 1/2 in. to 6 in. can be cut with tube drills.	8.	T	F
9. Glass breakage probably will result if the tube drill does not run true in the chuck of the drilling machine.	9.	T	F
10. A 1/4-in. electric drill motor of the type used in general shop work is suitable for glass drilling.	10.	T	F

UNIT H Installation

TOPIC 1--WINDOW AND OBSCURE GLASS

This topic, "Window and Obscure Glass," is planned to help you find answers to the following questions:

- What is the most common type of installation for window glass and obscure glass?
- What factors govern the selection of window glass or obscure glass for a given job?
- How is window glass installed in wood sash and in metal sash?
- What are the special requirements for installing glass in sliding windows?

One of the glazier's major concerns is the correct installation of window and obscure glass. In most of the jobs of this kind that he will be called upon to do, the glazier will set the glass into window sash. Heavy window glass and obscure glass may also be glazed into door frames. To do the best job possible, the glazier must know the different types of sash, the ways of preparing the sash before glass installation, and the various types of putty available. He must also know how to mix and thin putty or mastic correctly to avoid destroying their qualities and how to apply these materials most efficiently. Putties and other glazing sealants have been discussed in Unit F of this course. In this topic, the methods of installing window glass into wood or metal sash will be considered.

Selection of Glass

The type and thickness of the glass selected for a job must suit the requirements of the installation. If cost and quality are not factors in a job, the thickness of the glass is governed by the size of the opening to be glazed. Manufacturers' publications should be consulted to determine the maximum recommended sizes for window and obscure glass of various types and thicknesses. Domestic heavy sheet glass is not furnished in widths over 76 in. or in lengths over 120 in. Imported window glass sizes and quality do not necessarily conform to domestic standards.

Obscure glass (as discussed in unit F) is available in many patterns and is used in the trade where some degree of obscurity of images is required for privacy or for special architectural effects. The methods of installation of obscure glass are essentially the same as those employed for clear window glass, with the additional requirement that in general practice obscure glass is glazed with the smooth side out.

Any expected abuse or special usage of glass is not generally considered as a factor in selecting the thickness of window glass to be employed; however, it cannot be overlooked that the heavier glass will stand more abuse, sustain harder blows without breaking, and withstand greater wind pressure than the thinner material.

To obtain best appearance, the glazier should install window glass so that the draw, or distortion, is horizontal.

Installation in Wood Sash

Wood sash is by far the leader in residential windows now in use, new and old, and wood sash containing single or multiple lights is almost always glazed with window glass, except on a few special orders. The installation of window glass into a wood sash is much the same as other types of glass installation.

Rabbeted wood sash. The sash may be rabbeted out to receive the glass. In both new and old sash, if the rabbet does not line up evenly on all sides, the window glass will not lie flat in the opening.

Wood sash is generally glazed with the putty side out. The sash should be dry and correctly primed before putty is applied so that the pores of the wood will be filled, thus preventing the putty oils from being completely drained off before the putty has time to set, leaving nothing but powder. Sufficient back putty is applied to the rabbet to allow it to squeeze out when the window glass is pressed into the opening. The window glass should be pressed down evenly around the edges, with a uniform clearance maintained on all four sides between the glass and the sash. If there is a little too much clearance, it is possible to use small wood blocks to hold the glass more securely in the sash. Glazing points are used to hold the glass in place. The glazier should be sure some points are not forced down farther into the rabbet than others, thus causing waves in the glass. Points should be placed no farther than 24 in. apart around the wood frame. Where the sides are 12 in. long or less, one point centered on each side should be sufficient.

Special point hammers, guns, or large chisels are best used to install points. These tools, which have been described in Unit E of this workbook, work most efficiently and also help to prevent the glass from breaking. Points should be started in the upper right-hand corner of the sash and run down the right side and across the bottom. The sash is then turned over and the procedure repeated for the remaining side and the top. Care should be taken to see that the points are driven down far enough into the wood frame so that they do not stick up into the top sight line of the facing putty. Also, when selecting glazing points to be driven into the muntin bar, the glazier must be sure that they are not too large for the sash, which will cause them to go through the muntin and break the glass on the other side.

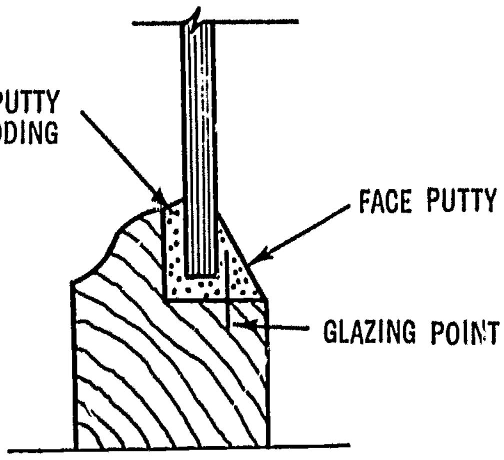
After points are installed, the remainder of the glass rabbet is filled with putty of the same consistency as the back putty. This facing putty is run in a neat trim line 1/16 in. below the sight line at the top of the rabbet (Fig. H-1). Much practice is required for the glazier to make a neat corner miter with a workmanlike finish. To match the straight putty faces, skill should be developed so that

putty is touched up as little as possible. After a little practice, the first passes always turn out the best. Facing putty works best at temperatures above 40° F.; for this reason, sash and door glaziers working on easels use heated "putty boards."

When surplus back putty is back cut or stripped off, the back-putty line should not be undercut. If there are areas where the back putty has not oozed through, a soft back-fill putty should be run into the unfilled spots. Undercutting of back putty is avoided for several reasons other than appearance. Just as on face putty that is flat or undercut, water will stand on the back putty and, in due time, leaks will break down the bond between the glass and the putty. Also, an undercut in the small area between the glass and the rabbet creates a catch-all for grease and dirt. Undercut putty will also prevent the painter from doing a correct painting job, because the putty will not be sealed to the glass.

Putty smudges or smears in long sweeps around the perimeter of the glass or across the outside surface of the glass not only make the window glass harder to clean after the putty has set, but are also signs of sloppy workmanship. Sash of any kind should not be handled or operated after puttying until the putty has set.

Fig. H-1. Face glazing in wood sash



<u>Wood sash with stops</u>. Window glass is set into sash with wood stops using much the same procedure that is employed for setting the glass into face-puttied, rabbeted wood sash. When setting the stop or bead into the glass, the glazier must be sure the putty or caulking is between the glass and the bead. The top stop is usually applied first. If the stops are tight and the miter corners have to be driven in tight against the window glass, care should be taken to prevent the stops from being too tight against the glass. When stripping the surplus putty or compound from both sides of the window glass, the glazier should be sure not to undercut the putty at the sight line. When the glazier is required to nail the glass stops into place, the proper tool for setting the nail head below the wood surface is a nail set, which prevents the occurrence of hammer marks around the area where the nail is driven in.

Installation in Steel or Aluminum Sash

Metal windows should be aligned correctly (racked) and adjusted before any window glass is installed. Casement metal windows, which are the most

common of this type, require approximately 3/16 in. to 9/16 in. stand-out of the bottom rail of the vent frame from the fixed sash when the top rail is tight to the sash. Racking may be done in several ways, but one of the best methods is the following: taking the edge opposite from the hinge edge, hold the bottom with one hand and push the top inward so that when the vent is closed, the top touches the frame first. Then pull the bottom tight also.

Before the sash frame is filled with bedding putty, the rabbet groove should be free from plaster or dust. Small welds or burrs in the corners of steel sash should be knocked out with a cold chisel. Otherwise, the window glass will not lie flat, and runs may be started in the corner of the glass with any movement of the vent. Screws used to fasten handles or regulators protrude through the "Z" section of the frame, and the window glass should be notched around these points. Steel sash should be primed to prevent rust.

Bedding on metal sash has the same effect as on wood sash, making an even surface for the glass to be held against and making the joint moisture-proof. A perfect seal is just as important with metal as with wood sash, because the constant presence of moisture will soon cause the metal to rust or corrode away under the paint and putty. Putty will not stick to greasy or dirty metal sash. Back putty on metal windows should be held to a thickness of 1/8 in.; too small an amount of putty dries out and loses its suction-like holding power, allowing the glass to loosen. The window glass should be cut shy enough from the inside frame dimension to allow putty to surround the glass on all sides.

Glazing clips for metal sash differ from points for wood sash in that they are made in the form of small springs that fit holes in the frame. They are usually called spring wire clips. One leg of the clip keeps pressure on the glass to hold it in place in the frame until the putty has set. Wire clips are spaced approximately 18 in. on centers around the frame.

Face putty is used to fill in the remainder of the sash and is faced off in a triangular fillet holding down the top edge 1/16 in. below the sight line of the back rabbet of the frame. Face putty should be packed into the corner of the frame so as not to permit air spaces that will allow the putty to dry out unevenly and crack out or pull away. Neatness is necessary in metal window-frame facing to ensure that when the putty is painted it will look like a metal extrusion. When cutting off back putty surplus, the glazier should be careful not to undercut. If there are any voids in the back putty, they should be filled in before painting.

The glass should be pressed into the metal frame very carefully. Too much back putty between glass and frame will cause the glass to be wavy wherever the spring wire clips are installed. Broken window glass will be kept to a minimum if the wire clips are not allowed to snap down on the edge of the glass.

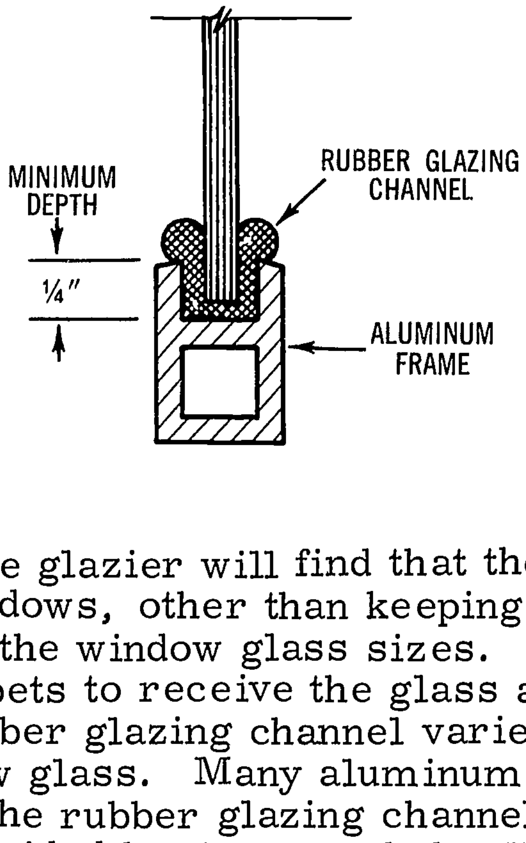
Safety first should be stressed in window glass installation. Window glass, being the thinnest type of glass, will stand only a limited amount of pressure. When the window glass lights are forced into the back putty, the thin glass can easily be broken if too much pressure is applied. It is better to apply the

pressure around the perimeter of the glass than in the center; then, if the glass breaks, the glazier's arm and wrist are not likely to be cut by going through the window glass.

Metal stops. Window glass set with metal stops (underwriters) or angles should be bedded sufficiently so that when the glass is pressed back against the rabbet, the compound is extruded well around the edge of the glass. When the stop is applied, the putty or compound should center the glass in the rabbet, leaving the proper amount of compound on both sides of the window glass. Metal stops are held on with screws or stove bolts. All voids are to be filled, and surplus compound from both sides of the glass should be removed without undercutting or feathering the edges.

Sliding windows. In sliding windows (or full surround), the perimeter of the glass is surrounded with metal extrusion to which is attached weather stripping, roller guides, locks, and hand pull hardware (Fig. H-2). When assembled, the frame itself is not very rigid; the window glass and rubber glazing channel play a large part in the rigidity and smooth operation of the window.

Fig. H-2. Full-surround sash



On new or replacement installations, the glazier will find that the most important consideration in glazing sliding windows, other than keeping the glass square, is the correct measurement of the window glass sizes. The reason is that the extrusions that form the rabbets to receive the glass are normally standard in width and depth, but the rubber glazing channel varies in weight to fit the different thicknesses of window glass. Many aluminum frames do not have a web in the extrusion to give the rubber glazing channel support from the back; in such a case, support is provided by the extruded roll or lip on the glazing rubber itself. Also, depth dimensions of the glazing channel vary considerably. Since the gasket or glazing channel is made of a flexible material, the glass size must be correct. If the size is under the correct measurement, the frame will not be held rigid or square laterally. On the other hand, if the glass is too large and the channel is driven on with a heavy rubber mallet or block of wood, the glazing rubber will stretch, but in time it will try to acquire its original dimensions. With the corners held firm and rigid, the only place the frame will expand is in the center of the rails or stiles, which will cause a bow in the extrusions.

Care should be taken on frame installation to prevent cutting the gasket or glazing channel when setting the extrusions over the rubber. Corners should be mitered or wrapped around, with the back cut out, but not through the face or roll flange (Figs. H-3 and H-4). Stretching the rubber on application will cause it to draw back later and open the corner so that water can enter (Fig. H-5). Any joints except corner miters should be made at the top center to minimize leaks. If leaks are anticipated because of environmental conditions, the joint should be sealed with caulking or a flow-in sealer.

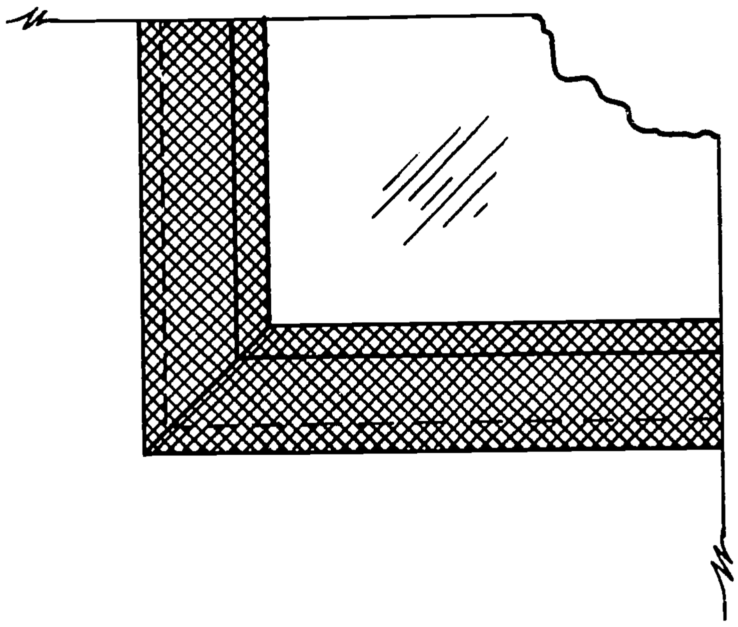


Fig. H-3. Corner with mitered channel

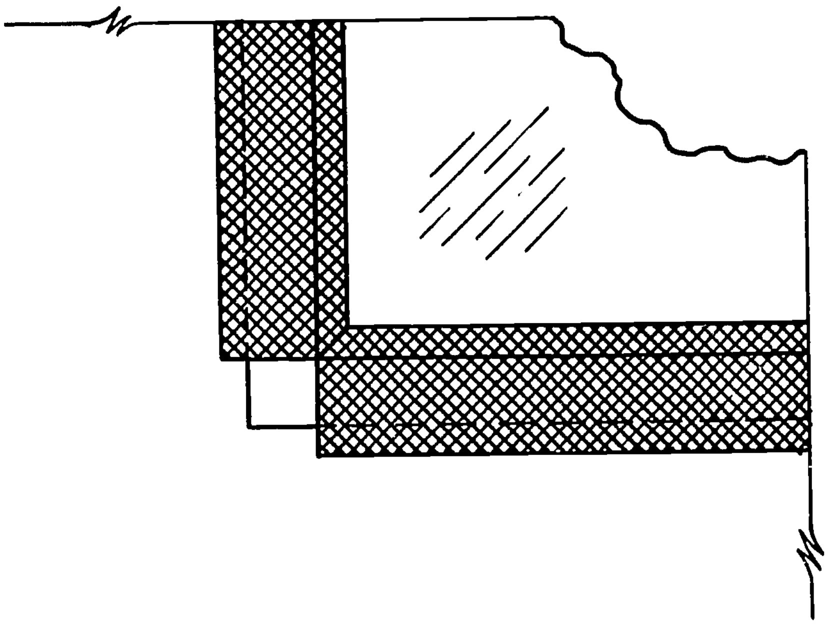


Fig. H-4. Corner with cut channel

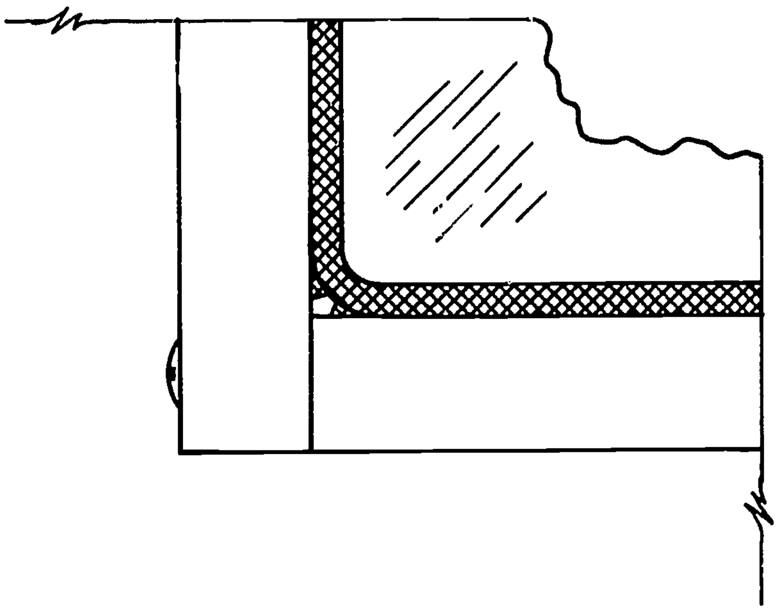


Fig. H-5. Corner with stretched channel

When glazing channel rubber is used around the perimeter of the glass to hold it in a metal frame, at no time is the exposed roll or flange to be cut off with a razor blade because it does not fit snugly to the frame; instead, the rubber should be forced back with a block of hard wood or a blunt tool so that it does fit snugly. If it will not drive back, the rubber channel is probably the wrong size, or it should have been lubricated. If new rubber does not have a waxy or treated feel and does not slide easily, a rubber lubricant can be used to aid installation.

Study Assignment

Glazing Manual, p. 3, "Preparation by Others Before Glazing"; pp. 4 and 5, "General Conditions Governing Glazing," paragraphs 1-6; p. 7, review paragraphs on putties; pp. 14-16, study drawings and table of clearances and tolerances as applicable to window-glass installation.

UNIT H--INSTALLATION

TOPIC 1--WINDOW AND OBSCURE GLASS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The installation of points in wood sash is done with special point __1__, __2__, or large __3__.	1. ______ 2. ______ 3. ______
2. Glazing points should be placed no farther than __4__ apart around the wood frame.	4. ______
3. Small burrs in corners of metal sash, if not removed prior to glazing, can cause __5__ in the glass.	5. ______
4. Heavy sheet glass is furnished in widths up to __6__ and lengths up to __7__.	6. ______ 7. ______
5. The allowance for edge clearance for a 25 sq. ft. light of 7/32-in. thick sheet glass is __8__.	8. ______
6. Sheet glass should be installed with the wave __9__.	9. ______
7. The use of a __10__ will prevent damage to wood stops by hammer marks.	10. ______
8. Steel sash and putty should be painted within __11__ after glazing.	11. ______
9. Aluminum sash should be cleaned with __12__ before glass is installed.	12. ______
10. Wood sash is generally glazed with the putty on the __13__.	13. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Wood sash may be installed as soon as it is puttied.	1.	T	F
2.	Steel sash should always be back-bedded.	2.	T	F
3.	Window glass and obscure glass are glazed by the same methods.	3.	T	F
4.	Obscure glass is manufactured in many patterns.	4.	T	F
5.	Obscure glass of 7/32-in. thickness may be glazed in doors.	5.	T	F
6.	Wood sash requires a heavier grade of glass than steel sash.	6.	T	F
7.	Putty is held 1/16 in. short for painting.	7.	T	F
8.	Brads may be used as glazing points.	8.	T	F
9.	The approximate spacing of wire clips around metal sash is 18 in.	9.	T	F
10.	Obscure glass is glazed with the smooth side out.	10.	T	F

UNIT H--INSTALLATION

TOPIC 2--PLATE GLASS

This topic, "Plate Glass," is planned to help you find answers to the following questions:

- How do the requirements of plate-glass installation differ from those of window-glass installation?
- How is plate glass installed in wood sash? In metal operative sash? In store front sash?
- What tools and equipment are employed in the installation of plate glass in various types of sash and frames?

Although the number of lights of window glass installed per year far exceeds the number of lights of polished plate glass installed, plate glass is the most important product in the flat glass industry because the total number of square feet installed per year far exceeds the number of square feet of window glass. A knowledge of the correct installation of plate glass is therefore of great importance to the apprentice glazier.

Since the two surfaces of plate glass are perfect polished parallel planes, it is imperative that plate glass be handled with even closer adherence to proper glazing procedures than is the case with window glass. The apprentice glazier should become familiar with the many types of plate glass and with the limitations of each in regard to use and installation.

A great many materials used in setting plate glass are the same as those used in setting window glass. For example, mastics, putty, caulking, sealers, and extruded rubber, vinyl gaskets, or channels are recommended for setting all types of glass, except that as the thickness of the glass varies, the materials used in making the installation also vary. Differences in procedure are due mostly to the differences in weight.

Installation in Wood Sash

Since its greater thickness makes plate glass much heavier per square foot than window glass, a sash structure that is adequate in one case may not be suitable for the other. The glazing rabbets and grooves required for plate glass installations in wood sash should be true and plumb, and the sash must be rigid enough to withstand the load. The proper edge clearance on all four sides of the glass is very important, not only to allow for expansion but also to allow for movement of the structure and for settling.

To avoid distortions in the plate glass, special care should be taken in application of the putty to ensure that the plate glass is not bowed or pulled in too tight in some places. As an example, if the ends or corners of the glass are

backed by lumpy or unmixed putty and the putty is pressed out in the center of the sash, the perfect reflection expected from plate glass will not be obtained in the area that is pulled in too tight.

Special care shall also be taken when the glazing points are set. Whether this is done with a special point driver, glazing hammer, or heavy chisel, if the steel surface of the tool is rough or burred from misuse, it will scratch the surface of the plate glass. By Moh's scale, which is a measure of hardness on which a diamond is equal to 10. 0, plate glass is 5.5 to 6.5, which is less than the hardness of the unpolished surface of a flame-finished material such as window glass.

Installation in Steel or Aluminum Operative Sash

Setting plate glass in steel or aluminum sash is the same as setting window glass, with one exception. Plate glass of 1/4-in. thickness weighs twice as much as double strength window glass and just under three times as much as single strength, and thicker lights of plate weigh proportionately more. This factor alone requires special blocking in the vent sections to prevent them from sagging. The extra weight will also demand sufficient points on all four sides to keep the glass from pulling away from the back putty. If this bond is loosened after the putty has begun to set, the glass will become loose in the frame. Also, the cracks that develop make good collectors of moisture and water to start breaking down the remainder of the bond between glass and compounds.

Sash that is free from grease, dirt, and dust; putty that is mixed to perfect consistency; and the installation of spring clips every 12 in. are important here, but will not alone make a perfect job. Most important are the correct measurement of the plate glass and the recommended edge clearances, which are not seen in the finished job, but which must be right. A plate with only 1/16-in. coverage on any side does not have enough bond to support the glass correctly for any length of time.

Installation in Store Front Sash

The installation of plate glass in store fronts makes up a large and important part of the glazier's work. The methods employed in this type of installation are discussed in the remaining paragraphs of this topic.

Measuring and cutting. The first precaution in installing plate glass into store front sash is to be sure that the opening is set true and plumb and that the sash is not bent or out of line. If plate glass cannot lie perfectly flat, pressures will be exerted which may cause the glass to break. In measuring all the dimensions before cutting the plate glass, the glazier must remember the recommended coverage for the glass and should know whether the opening is square. If the glass is measured correctly but the opening is out of square, a great deal of time will be needed to make the glass fill the opening after it has once been cut. In field cutting, the glass can be cut on A-racks or in front of the opening.

Two methods can be used to cut glass in the opening. First, if the glass is nearly the correct size in both dimensions, one side can be trimmed to allow the glass to get closer to the sash, or both sides can be cut first to a close dimension. The remainder of the glass can be trimmed by sight, using the sash as a guide line and finishing up the correct coverage with a breaker or offset pliers. Second, the glazier can use a slip stick to measure the height off the setting block points and mark the glass, cutting against either a straight-edge or a chalk line. If there is only one plate to an opening, the width can be measured in the same way by allowing the correct coverage on two sides. In multiple openings of more than one plate each with division bars or mullions, the height can be cut as previously mentioned and the sides stripped after the glass is in the opening. When the last glass is cut, it is placed so as to overlap the last plate set and then cut to the correct size, using the last plate set as a guide line and making sure to allow for correct coverage on both sash and division bar.

Setting blocks. Setting blocks should be placed one-fourth of the way in from the edge of the plate glass that is to be installed. If the area of the plate glass is less than 75 sq. ft., two setting blocks are sufficient. For any plate glass over this size, multiple setting blocks are necessary, but this leads to problems. When two setting blocks are used on a side, they should be close together so that they act as one, not distributed over the length of the opening; otherwise, the plate is almost certain to rock.

Wood should not be used for setting blocks if the plate is large enough to require two men to set it. Lead, leather, rubber tile, or plastic should always cover metal setting blocks so that the plate glass edge will not come into contact with the metal, creating a chip or run. It is always a good safety practice to let the cover extend past the metal setting block to ensure that the glass does not rest on the metal. No material that will compress under the weight of the glass should be used; if one end of a plate that is tall and narrow drops a fraction of an inch because the setting block on that end compresses, the top will move many times that amount.

Safety and care should be practiced at all times when plate glass is being set. One practice that should become automatic is the use of temporary or "safety" blocks while setting plate glass. If the glass were to slip off the setting block down onto the metal sash or a hard sill, a very serious condition could arise more rapidly than the glazier could correct it. If hard rubber or felt safety blocks are wide enough and thick enough to be under the plate and extend about an inch out from the permanent setting block, a piece of glass that slips cannot drop very far before it falls onto the safety blocks. This will save the plate and may prevent serious accidents. After the last plate has been moved into place, the permanent setting blocks should be reset.

Handling and placing the glass. Large plates are stored in racks, then moved to the truck on dollies (Fig. H-6). On the job, the glazier moves the plates from truck to installation point by hand. He must hold the glass high in order to maintain the best balance possible (Fig. H-7). If large "jumbo" plate is too heavy to be carried by two glaziers bucking on both ends, extra men should be furnished to help carry the load, using webs or suction cups. When correctly

cared for, suction cups will not turn loose while they are being relied upon to carry their share of the load. A cup should always be inspected before it is used, while the plate is still on the setting blocks. If there is a nick or cut in the rubber, it is unsafe to rely upon the suction cup.

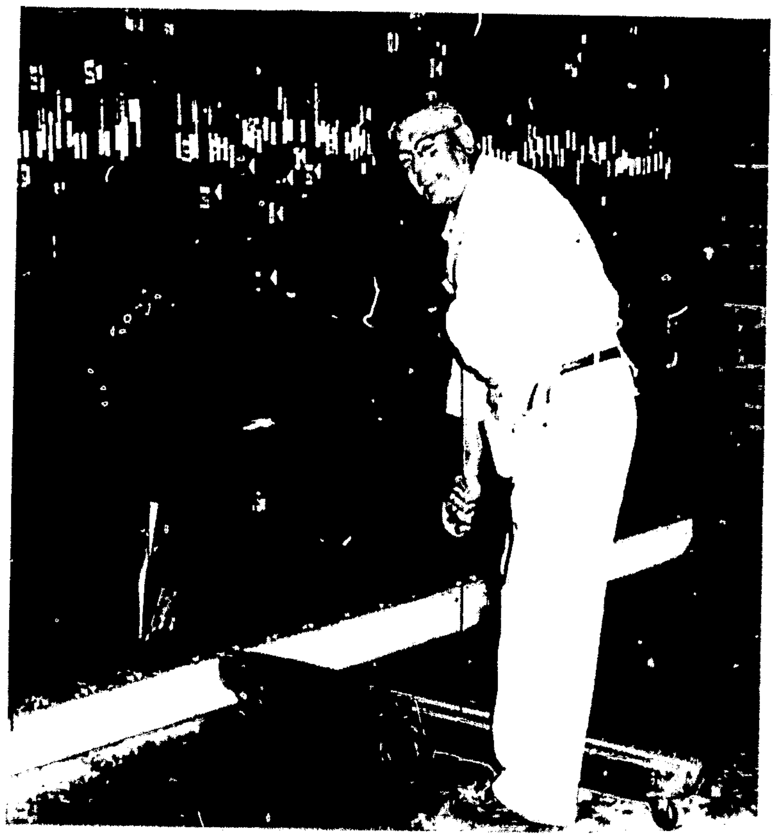


Fig. H-6. Handling glass on dolly

Fig. H-7. Carrying glass with hand grips

Straps, webs, or slings are used under the edge of a plate to carry the weight. They should be set in approximately the same location as the setting blocks will rest; this takes the pressure off the center of the plate glass. The straps will not be cut if they are not allowed to work back and forth or to slip along the sharp edge. When glass is being set into an opening, straps that have rings or reinforcements on the ends can be used only as far as the setting blocks in front of the opening. Then the straps must be exchanged for others that can be pulled through after the glass is in the sash and close to its final resting place. The web or strap should never be pulled to the outside or "set" side of the sash, but to the inside, so that the pressure will not force the plate glass off the setting blocks. The strap should be toward the center from the setting block so that it can be slipped to the center of the plate just before it is to be removed. The bow in the plate will then allow the strap to slip out more easily. When the top of the installation is high over the glaziers' heads, one man may control the top of the glass from a ladder.

A large chisel and a small block of wood for a leverage point can be used to raise a large plate to line it up in the opening. This saves taking the plate back out of the opening to get a hold on the side or using suction cups. Also, the plate can be moved with much greater control in this way than by the other two methods. Care should be taken to protect the edge of the glass in much the same way as when it is set on a setting block, so that it will not chip or start a run. Some tool manufacturers make special lifting pliers that will also permit lifting the plate without removing it from the sash. If clearance is small, glass can be handled only with suction cups while it is installed (Fig. H-8).

Fig. H-8.
Installing plate where clearance is small

Completing the installation. After the plate glass is set into the opening with the correct clearances allowed on all sides, the face section of the sash should be put in place with care so as not to impose a strain on the glass at any one point. Care should be taken to tighten all lugs or screws firmly, but not too tightly, with the same amount of pressure all the way around the perimeter of the plate. Each lug or screw should be tightened a little at a time until all the fasteners are brought up evenly to the required tightness. Division bars should also be tightened with the same pressure so as not to cause breakage.

Flush setting of plate glass requires much greater accuracy in measurement than setting into exposed sash. Flush-set glass also has less coverage than exposed-sash glass. Care should be taken not to allow foreign material such as plaster or sand to be left in the flush-set channels. Rubber wedge gaskets are often used for flush glazing, and the same rules apply as in full-surround windows, except that the gaskets are two-piece and the face gasket is rolled with special tools. Care should be taken not to stretch the gaskets; they will shrink back from the corners if stretched. The gaskets are cut on the back side to allow turning at sash corners.

If springs and putty are used in the flush glazing, the movement of the glass should not be allowed to cause the springs to work behind the edge of the plate. If the clips are too narrow and work their way close to the edge, any sharp movement may cause chipping of the edge and a run in the plate.

Blocking plate glass so that there is no expansion room in either flush-set or exposed sash will create pressures that could very easily cause the glass to explode in very warm weather. If blocking is required to prevent movement caused by heavy equipment or structure movement, a soft piece of material such as redwood should be used so that the glass, if expanded, can compress the blocking material easily. Lead or hard materials should not be used, since they tend to increase the danger of glass breakage.

In the installation of heat-absorbing or glare-reducing plate glass, special care should be taken to hold the coverage to a minimum to avoid a "cold edge." The area where the glass is inside the sash does not receive as much heat as the exposed area, and the colder areas do not expand evenly with the exposed areas. Chips or nips along the edge of this type of glass should be avoided because expansion, contraction, and pressure caused by the seams may start runs from the edges, even though there is no pressure from the sash or from the points where the glass is held secure.

Doors. Installation of door lights into metal door sash is done as follows: The light of glass is cut to the correct measurement, and the stops on one side of the frame are removed. Setting blocks are placed in the bottom, in the side that will be installed to the jamb, and in the upper corner on the opposite side. The glass is set on the blocks and laid flat against the back stop. Next, the front stops are applied. An adjustment screw is usually located in the upper part of the top rail of the door. The glass can be forced down into its blocked position and the door raised and leveled by screwing this adjustment screw down.

Study Assignment

Glazing Manual, p. 6 (paragraphs 12 and 14); pp. 14-16 (study drawings and the table of clearances and tolerances as applicable to plate-glass installation).

UNIT H--INSTALLATION

TOPIC 2--PLATE GLASS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Double-strength window glass weighs __1__ as much as 1/4-in. plate glass. — 1. ________
2. By Moh's scale, the hardness of plate glass is from __2__ to __3__. — 2. ________ 3. ________
3. Spring clips should be installed every __4__ in steel sash. — 4. ________
4. The most important factor in setting plate glass in steel or aluminum sash is __5__ __6__. — 5. ________ 6. ________
5. The first precaution in the installation of plate glass into sash is to ensure that the opening is __7__ and __8__. — 7. ________ 8. ________
6. In field cutting, plate glass can be cut on __9__ or in front of the __10__. — 9. ________ 10. ________
7. More than two setting blocks are needed if the area of the plate is __11__ or more. — 11. ________
8. Plate glass is set into an opening with __12__ straps. — 12. ________
9. A suction cup should always be __13__ before it is used. — 13. ________
10. Plate glass is moved to the truck on a __14__ and from the truck to the installation point by __15__. — 14. ________ 15. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Plate glass has one polished surface.	1.	T	F
2. More lights of window glass are installed than lights of plate glass.	2.	T	F
3. Heavy sheet glass weighs more per square foot than 1/4-in. plate.	3.	T	F
4. Distortions in plate glass can be caused by pinching the glass.	4.	T	F
5. Glazing points may be installed with a heavy chisel.	5.	T	F
6. Plate glass is softer than window glass.	6.	T	F
7. A coverage of 1/16 in. is enough for plate glass.	7.	T	F
8. More than one setting block can be used on one end of a plate of glass.	8.	T	F
9. Plate glass can be stripped after it has been placed in the opening.	9.	T	F
10. Setting blocks should be set evenly across the bottom of the plate.	10.	T	F

UNIT H--INSTALLATION

TOPIC 3--TEMPERED GLASS DOORS

This topic, "Tempered Glass Doors," is planned to help you find answers to the following questions:

- What are the special characteristics of tempered glass doors?
- What precautions must be observed in the handling of tempered glass doors?
- How are tempered glass doors installed and maintained?

Prior to the development of the all-glass door in 1937, glass doors were always encased in wood frames. Modern architectural designs make extensive use of glass entries of various kinds, many of which incorporate tempered glass doors (Fig. H-9). The installation and maintenance of tempered doors and their hardware is therefore one of the glazier's important concerns. If the correct procedures are followed, the installation of such doors is only a little more difficult than that of standard types.

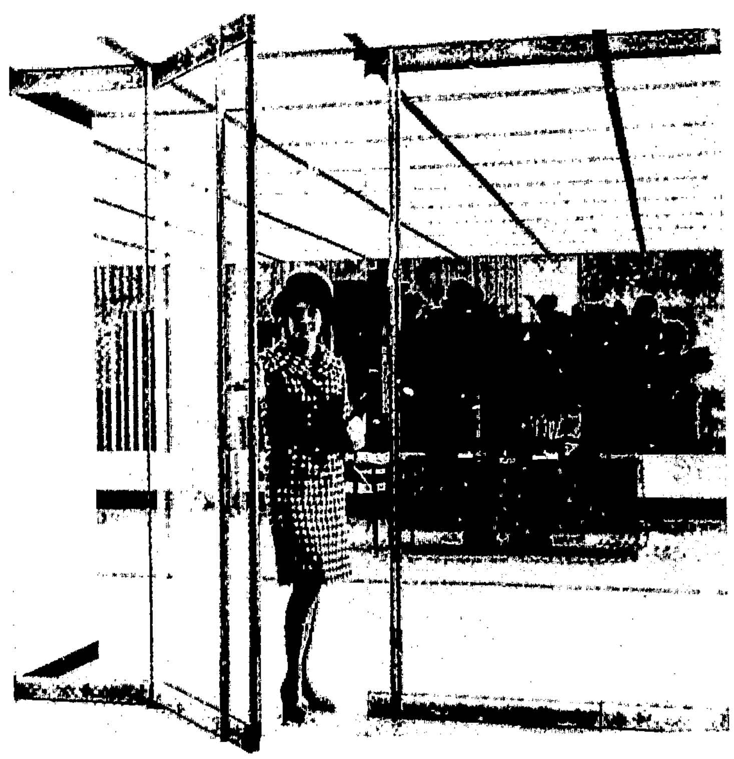


Fig. H-9. Tempered glass door

Characteristics of Tempered Glass Doors

Any of the usual methods of decoration can be used on tempered doors, but the surface of the glass must be decorated and completely fabricated before the glass is tempered. Any attempt at subsequent fabrication, including grinding, chipping, or sandblasting, is likely to result in the destruction of the tempered plate. Sandblasting can be no more than 1/32 in. deep, regardless of the thickness of the glass.

Tempered glass can be furnished with holes, notches, or bevels. The spacing of holes is related to the thickness of the glass and is governed by definite rules and specifications. Manufacturers reserve the right to refuse fabrication of notches and cutouts they consider impractical. They seldom encourage the use of bevels on tempered glass doors, for the resulting thin edge heats and cools too rapidly and therefore usually warps.

Tong marks will usually be found along one edge of glass that has been supported vertically for heat treatment. Slight mold marks appear near the edge of the plate if the glass has been supported horizontally, but these are scarcely noticeable.

Tempered glass doors can withstand from six to eight times as much shock as regular plate glass doors, they withstand thermal stress better, and they are adaptable to the usual means of burglar protection.

Handling Tempered Glass Doors

The glazier should keep in mind in handling tempered glass doors that they are considerably heavier than aluminum-frame doors. He should follow the correct safety practices for lifting and carrying glass, as outlined in Unit A of this workbook. A tempered door is lifted in much the same manner as large plate glass and is carried upright to minimize stresses. The added weight of tempered doors also makes extra care necessary in loading and tying them onto racks for transport; they must be secured in a manner that will prevent their falling over or sliding out at the bottom.

Tempered doors and their hardware are expensive, and every care should be taken to avoid damaging the glass or disfiguring the hardware. Although tempered doors are made of heavy plate glass, they will chip if they are not handled carefully. In handling a pair of such doors, special care should be taken to prevent the two door edges from hitting and thus chipping each other.

Installing Tempered Glass Doors

The frame that will carry a heavy tempered door must be designed to be strong enough to support the load and to hold the door in correct alignment throughout its range of operating positions. Swing-type tempered doors are made in standard and custom sizes from 30 in. x 84 in. to 60 in. x 108 in. with standard clearances and standard pivot distance (2-5/8 in. from pivot center to jamb edge of door fitting). The net size of the opening must be accurately established; tolerances are minimum, and no racking adjustments can be made. However, the top and bottom pivot assemblies in the doors do allow a small lateral adjustment of the edge clearances. The correct distance from the upper pivot center to the face of the jamb is 2-3/4 in.; this allows 1/8 in. swing clearance at the jamb. The 1/8 in. clearance is the typical minimum for tempered doors at the top and at each long edge; 3/16 in. clearance is typical at the bottom (Fig. H-10).

The two pivot points in the head and base must be set plumb; the lack of racking adjustment makes it essential that these points not be out of plumb either in-

and-out or sideways. Occasionally, a door may come from the factory warped, but not often. It is nearly always possible to maintain the two points in perfect plumb. The distance away from the finish jamb may vary slightly, but not the vertical angle.

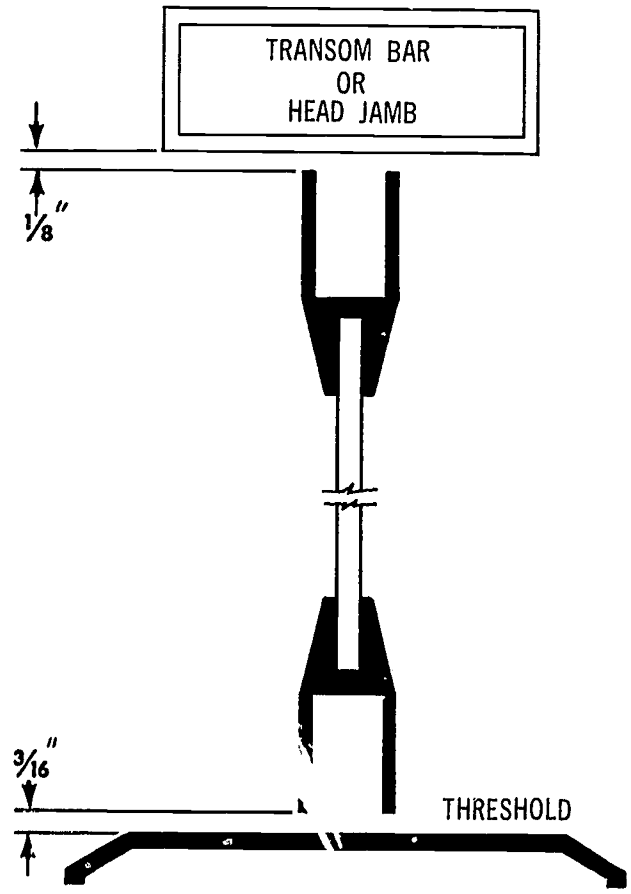


Fig. H-10.
Clearances in tempered glass door installation
(vertical section)

After the top pivot is made secure, the floor should be built up or cut down if necessary to fit the door more closely into place, with extra care being taken during this operation to ensure that the door will not move because of its weight. Then the door hardware must be installed into the lower rail of the door. The manufacturer supplies shop drawings with each tempered door, and the layouts and drill sizes specified should be followed closely. If the drawing calls for four 1/4" x 20 flat-head machine screws to hold the adapter plate in the lower rail, all four screws will be needed; if one of the screws breaks off, it should be replaced to ensure a strong installation. If the door must be raised or lowered because of required adjustments in the hinge, shims supplied by the manufacturer can be added or removed from the pivot assembly in the bottom rail.

After the assembly is complete in the lower door rail, the door is placed on the hinge pivot. A small amount of grease at the end of the hinge spindle will lubricate the spindle sides and mating parts upon assembly and make it easier to remove the door for any further adjustments that may be required. Lubrication also helps prevent rusting of these hinge parts. After the door has been lifted into place, it will have to be opened to approximately 35° to expose the top pivot assembly so that it can be operated for assembly. The top pivot pin, also greased, should be run down all the way into the bushing in the top rail. If the pin enters the bushing only partially, not enough of the surface of the bushing will come into contact with the pivot pin, and the pin and bushing will not last very long without wearing out completely or at least wearing out enough to cause the outside corner of the door to drop.

When the pivot pin has been put securely in place, the door should still not be allowed to shut under its own control; it should be held until the glazier has made sure that the door edges do not bind against the frame. In a pair of doors, the two doors must not be allowed to strike each other on their leading edges. Pivot adjustment must be checked before the door is finally turned loose for operation.

If the clearances are correct and the door passes through the frame correctly, then the closing speed should be adjusted. Floor closers are most commonly used with tempered doors; these should be the heavy type to carry the door's weight. The closing speed and the latching speed are in general adjusted from the top of the bottom hinge by means of set screws; the closer mechanism does not have to be removed or taken apart to be adjusted. The setting of the correct closing speed of a heavy tempered door is very important; because of its weight, the door swinging too fast back to center could very easily knock a person down.

The hardware is installed with bushings and felt pads to protect the glass from direct contact with the metal parts. Care should be taken to ensure that hardware is tight and will not work loose. Thresholds or cover plates cover the floor closer and prevent tampering with the hinge. Locks and strike plates are much the same as for aluminum-frame doors. The lock or dead bolts in a pair of doors should be operated several times to make sure they line up correctly. Push or pull bars are usually made of aluminum, bronze, or Lucite or other plastic.

If plaster or terazzo workers are to follow up the glazing of the entry, the aluminum rails of the tempered door should be protected in much the same way as other aluminum finishes.

Maintenance of Tempered Glass Doors

The most frequent replacements on tempered doors are the hinging adjustment screws. If a door is forced to swing past the end of the hold-open or stop on the hinge, damage can occur in two ways: first, the hardened steel spindle can be snapped off, but the strength of the heavy spindle makes this unlikely; second, the machine screws in the arm hardware can be broken. Continuous abuse of the door can cause the lower rail to become so loose that it will have to be replaced.

Study Assignment

1. Architectural Data Handbook, pp. 72 and 73.

2. Study sales literature describing the tempered glass doors produced by American manufacturers. (This material will be found in the classroom library.)

UNIT H--INSTALLATION

TOPIC 3--TEMPERED GLASS DOORS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The all-glass door was developed in __1__.	1. ______
2. Sandblasting on tempered glass doors can be no more than __2__ deep.	2. ______
3. Tempered glass can be furnished with __3__, __4__, or __5__.	3. ______ 4. ______ 5. ______
4. A tempered glass door must be carried in the __6__ position.	6. ______
5. Tempered doors are made of heavy __7__ __8__.	7. ______ 8. ______
6. Tempered doors are available in sizes up to __9__.	9. ______
7. No __10__ adjustment can be made in a tempered door installation.	10. ______
8. The two pivot points in a tempered door must be set __11__.	11. ______
9. The door should not be allowed to shut under its own control until it has been ascertained that the __12__ __13__ do not bind.	12. ______ 13. ______
10. A heavy tempered door that closes too __14__ can be a safety hazard.	14. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Tempered glass doors cannot be fabricated on the job.	1.	T	F
2.	Sandblasting and decorating are done on glass before it is tempered.	2.	T	F
3.	Tempered glass doors can be made burglar proof.	3.	T	F
4.	Manufacturers encourage the use of bevels on tempered doors as it makes the glass easier to temper.	4.	T	F
5.	Glass can be tempered in either a vertical or a horizontal position.	5.	T	F
6.	Tempered glass doors are stronger than other doors but are very sensitive to temperature changes.	6.	T	F
7.	The standard distance from pivot center to fitting edge for tempered doors is 2-5/8 in.	7.	T	F
8.	The distance away from the finish jamb need not be constant from top to bottom of the door.	8.	T	F
9.	The first pivot secured in installing a tempered door is the top one.	9.	T	F
10.	The door is put on the lower hinge pivot before the hardware is installed on the lower rail.	10.	T	F
11.	When a floor closer is employed in a door installation, closing speed is adjusted on the bottom of the top hinge.	11.	T	F
12.	Extra heavy floor closers are needed for tempered doors.	12.	T	F
13.	The parts that most frequently require replacement on tempered doors are in the hinges.	13.	T	F
14.	The pivot pins should be greased.	14.	T	F
15.	The top pivot pin should be adjusted to enter only partially into the bushing.	15.	T	F

UNIT H--INSTALLATION

TOPIC 4--INSULATING GLASS UNITS

This topic, "Insulating Glass Units," is planned to help you find answers to the following questions:

- What factors must be considered in the installation of insulating glass units?
- What clearances apply in such installations?
- What procedure is followed for the installation of insulating glass units?

Although insulating glass units are used less commonly in California than in colder parts of the country, they are used in this region occasionally, particularly at high elevations, and the apprentice glazier must be sufficiently familiar with their installation to know how to proceed.

Insulating glass units are available in various glass combinations, but glass thicknesses in the same unit cannot differ by more than 1/16 in. Insulating glass units are produced in many standard sizes in square or rectangular shapes, and they can be ordered to specified straight-edged patterns within the manufacturing limitations discussed in Unit F of this workbook. Most units are made up with two lights, but specially made units with three or more lights are sometimes used in scientific or industrial applications. One type of insulating glass is set in metal channel all the way around; another type is bonded to inside spacers or fused together at the edges. The latter type has no protective metal surround.

The glazier must check very carefully when he plans the glazing job to see that the metal sash details provide sufficient rabbet depth and height to accommodate the insulating glass and sufficient strength to support it. He should also be aware that the room-side light of an insulating glass unit may crack if excessive hot air is directed onto it from a furnace register or wall heater. If he should find any such dangers, he should call attention to them.

A factory-sealed insulating glass unit is subject to continuous movement because of changes of temperature and barometric pressure. Adequate provision should be made for expansion and contraction of all metal glazing members--long, continuous expanses of metal in particular--to protect the glass from pressure resulting from such movement. Neoprene or vinyl spacers must be used to ensure that there will be no contact between sash and glass at any point, for such contact can result in glass breakage or seal failure. When an insulating glass unit is transported from one elevation to another, the pressure within the unit should be adjusted accordingly if this is possible. This is done on some units by means of pore seals; outlets can be established in other types of units. Areas of insulated glass should never be covered with paper or paint; the covering acts as a heat trap and may cause glass failure.

The correct procedure for glazing insulating glass should be followed in every detail:

1. Make sure that the sash opening is square and plumb so that correct face and edge clearances can be maintained.

2. The face clearance between glass and stops must not be less than 1/8 in. Clearances at each edge between glass and frame must not be less than 1/8 in. for 1/2 in.-thick insulating glass, and 1/4 in. for units over 1/2 in. thick.

3. Whenever possible, use neoprene setting blocks and spacers to ensure uniform clearances on all units set with face stops. Wood setting blocks are permissible with some types of insulating glass, however. Use metal glazing clips for 1/2 in.-thick units in sash without face stops. Locate setting blocks or glazing clips at the bottom of the unit in from each corner a distance equal to one-fourth the width of the glass. Use spacer strips at the sides and top of the unit to ensure uniform setting.

4. Use a good knife-grade, nonhardening glazing compound, free from corrosive materials, and do not dilute or thin the compound. Do not use putty. Use a full bed of compound on the bottom of the sash, and use enough at the sides and top to make a weather-tight seal. If a void is left in the bottom rabbet, provide weep holes for drainage of moisture to the exterior. Trim and slope glazing compound from the glass to the outside stop for water drainage.

5. Do not nip corners or grind edges.

6. Install any units that include heat-absorbing glass so that the heat-absorbing glass is on the outside.

Study Assignment

1. Glazing Manual, p. 2 (paragraph on insulating glass); pp. 17 and 18.

2. Examine manufacturers' catalogs and sales literature describing insulating glass units. (This material will be found in the classroom library.)

UNIT H--INSTALLATION

TOPIC 4--INSULATING GLASS UNITS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Insulating glass units are available in many __1__ sizes in square or rectangular shapes, and they can be obtained on special order to certain specified __2__.
   - 1. ________
   - 2. ________

2. In one type of insulating glass unit, the two lights of glass are set in a surrounding __3__ __4__; in the other type, the lights are bonded to inside __5__ or __6__ together at the edges.
   - 3. ________
   - 4. ________
   - 5. ________
   - 6. ________

3. Metal sash for an insulating glass unit must provide sufficient rabbet __7__ and __8__ to accommodate the glass.
   - 7. ________
   - 8. ________

4. The room-side light of an insulating glass unit may crack if excessive __9__ air is directed onto it.
   - 9. ________

5. A factory-sealed insulating glass unit is subjected to continuous movement because of changes in __10__ and __11__ __12__.
   - 10. ________
   - 11. ________
   - 12. ________

6. When an insulating glass unit is moved from one elevation to another, the __13__ within the unit should be adjusted for the new location if means for such adjustment are provided.
   - 13. ________

7. Areas of insulating glass should never be covered with __14__ or __15__; the __16__ trapped by such covering could cause glass failure.
   - 14. ________
   - 15. ________
   - 16. ________

8. Setting blocks under insulating glass units should be located in from each bottom corner a distance equal to __17__ the width of the glass.
   - 17. ________

9. Insulating glass must not be __18__ at the corners or __19__ at the edges.
   - 18. ________
   - 19. ________

10. If a void is left in the bottom rabbet of the sash, __20__ __21__ must be provided for moisture drainage.

20. __________
21. __________

Tes.

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The air inside insulating glass units is dehydrated.	1.	T	F
2. Units can be made with lights of different thicknesses, so long as the variation in glass thickness does not exceed 1/16 in.	2.	T	F
3. Insulating glass units can be obtained in any specified pattern if 30 days are allowed for delivery.	3.	T	F
4. Putty is used in the ins*allation of insulating glass units.	4.	T	F
5. An insulating glass unit that includes a light of heat-absorbing glass must be set with the heat-absorbing light to the outside.	5.	T	F
6. The minimum face clearance for insulating glass units is 1/4 in.	6.	T	F
7. An insulating glass unit 1/2 in. thick should be face glazed with metal clips.	7.	T	F
8. Insulating glass units must be glazed with neoprene or vinyl setting blocks.	8.	T	F
9. An insulating glass unit should "float" in the sash.	9.	T	F
10. An insulating glass unit 3/4 in. thick should be set with edge clearances of 1/4 in.	10.	T	F

UNIT H--INSTALLATION

TOPIC 5--SLIDING ALUMINUM-FRAME DOORS

This topic, "Sliding Aluminum-Frame Doors," is planned to help you find answers to the following questions:

- How does the glazing of a sliding aluminum-frame door differ from that of a regular door?
- How are the stationary and sliding panels of the door unit designated on the work order or blueprint?
- How is a sliding aluminum-frame door unit installed in a rough opening?

Sliding aluminum-frame doors--or patio doors, as they are often called--are made up of stationary and sliding panels which are usually preassembled in the frame before being brought to the job site. The assembly and installation procedures given in this topic apply to sliding aluminum-frame doors in general, but each manufacturer provides a detailed instruction sheet with his door unit, and the manufacturer's instructions should be consulted to ensure correct assembly and smooth operation of the unit.

Assembly and Installation

In the glazing of a regular door, the glass is installed in the door; in the glazing of a sliding door, however, the door is built around the glass. The glass is first cut to size, and a U-shaped piece of vinyl is then applied around all four edges of the glass. Next, the top and bottom rails and the sides (stiles) are driven on carefully with a rubber mallet. Each rail and stile has a channel that fits very tight over the U-shaped vinyl. The vinyl is manufactured in different thicknesses, permitting the same door frame to be used for 3/16-, 7/32-, or 1/4-in. glass. The right vinyl must be used for each thickness of glass.

The glazier must be careful not to pinch or cut the vinyl with the sharp edge of the glass when he is putting on the rails and stiles. These metal members must be hit squarely on the back, not at an angle; otherwise, they will be dented or will go on unevenly, and glass breakage may result. A stile must not be hit where the holes for the lock are cut out; this area can easily be dented, with the result that the lock will fit improperly and the installation will show poor workmanship. Also, the stiles must be put on straight, with no bows, or the sliding panel and the stationary panel will not line up.

The assembly drawings that accompany a sliding-door unit portray the unit as seen from the outside of the building, looking in, with the sliding panel closed. The sliding panel is denoted by the letter "X," the stationary panel by the letter "O." If the work order or the blueprint for the unit shows "XO," it will be understood that the stationary panel is to be on the right, with the sliding panel

thus opening from left to right. If "OX" is specified, the stationary panel is to be on the left, with the sliding panel opening from right to left.

The stationary panel should be installed in the frame before the frame is installed in the rough opening; this makes a semirigid, preassembled unit that is easier to shift in the opening for best fit. The frame must be installed so that it will be level and square in the opening when the work is completed. The rough opening is seldom both level and square, and the frame is seldom a perfect fit; for these reasons, the glazier must usually block the frame with wood shims as necessary to make a level and square installation. The shims should be placed under the screw holes on the sill so that when the screws are tightened down, they will not bow or distort the frame. The inside of the nailing fin on the frame should be caulked before it is set into the rough opening.

After the frame is nailed or screwed (or both) in place, the sliding panel is inserted. On a typical patio door panel, an adjustment screw at the bottom of the stile permits raising or lowering the back roller to compensate for minor misalignment of the door.

Study Assignment

Examine sales literature and assembly and installation instructions for sliding aluminum-frame doors. (This material will be found in the classroom library.)

UNIT H--INSTALLATION

TOPIC 5--SLIDING ALUMINUM-FRAME DOORS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The letter "X" denotes the __1__ panel, and "O" denotes the __2__ panel on the drawing of a sliding door unit.	1. ________ 2. ________
2. If the blueprint shows "XO," the door will slide from __3__ to __4__ to open.	3. ________ 4. ________
3. Roller-adjustment screws permit compensation for __5__ __6__ of the door.	5. ________ 6. ________
4. The vinyl that fits around the glass is __7__-shaped in section.	7. ________
5. Vinyl is manufactured in different thicknesses so that the same door frame can be used with __8__ of different __9__.	8. ________ 9. ________
6. In the glazing of a sliding door, the __10__ is built around the __11__.	10. ________ 11. ________
7. If the blueprint shows "OX," the stationary panel will be on the __12__.	12.
8. The glazier must be careful in putting the stiles and rails on a panel not to __13__ or __14__ the vinyl with the __15__ __16__ of the glass.	13. ________ 14. ________ 15. ________ 16. ________
9. The assembly drawings portray the sliding door unit as seen from the __17__ of the building, looking __18__.	17. ________ 18. ________
10. The frame must be installed so that it will be __19__ and __20__.	19. ________ 20. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The letter "O" denotes the sliding panel.	1.	T	F
2. The stationary panel should be installed in the frame before the frame is installed in the rough opening.	2.	T	F
3. The letter "X" denotes the stationary panel.	3.	T	F
4. A rubber mallet is used to drive the stiles and rails over the vinyl-covered glass edges.	4.	T	F
5. A different type of door unit must be used with each thickness of glass.	5.	T	F
6. In driving the stile onto the panel, the glazier must avoid hitting the lock-cutout area on the stile.	6.	T	F
7. An important reason for putting the stiles on straight, with no bows, is to ensure that the two panels will line up correctly.	7.	T	F
8. The chief reason for employing good workmanship in installing a sliding door unit is that no final adjustment can be made to compensate for minor door misalignment.	8.	T	F
9. Sliding doors are glazed in the same way as regular doors.	9.	T	F
10. A sliding door panel in a unit designated as "OX" opens by sliding to the left.	10.	T	F

UNIT H--INSTALLATION

TOPIC 6--STORE FRONTS

This topic, "Store Fronts," is planned to help you find answers to the following questions:

- What proportion of the glazier's work is related to store front installations?
- What are the general classes of store front metal?
- How are store fronts of various types installed?
- How do the various types of door closers used in store front entrances differ, and how is each type installed and adjusted?

In many glazing shops today, particularly in city areas, at least 70 to 75 percent of the glazier's work is done on store fronts. Plate and other types of glass (and in some cases plastics) are used in such installations, but the glazing itself differs only a little from that done in any other type of metal sash. In most cases, at least three-fourths of the work of installing store fronts has to do with providing the framework for the glass.

Store Front Metal

Store front metal comes in many sizes and shapes, each different style requiring a slightly different method of installation. The apprentice glazier should become familiar with the fundamentals of installation for each style, since he can expect to spend a good part of his working life performing these operations.

The various store front metals provide a variety of glass setting units with harmonizing trim. Each piece of metal is intended both to support the installation of glass and to add to the appearance of the building on which it is used. Store front metal may be made of aluminum, steel, or bronze, but aluminum with an anodized finish is used most widely, partly because it is less expensive than other metals and partly because it is lighter and softer and thus easier to handle and work. Store front metal may be rolled or extruded, but most of it is extruded, as this gives a better surface, sharper lines, and greater rigidity. A review of the typical working drawings included as Plans 1-10 in Unit D of this workbook will provide the apprentice with many examples of the details and applications of store front metals.

During installation, anodized aluminum should be protected from wet mortar or plaster, acids, or strong alkalis. Any of these will destroy the anodized finish, which can be restored only at the factory. It is also necessary to guard against electrolysis, which will occur if aluminum and certain other metals are in contact in a place where moisture is present; if the aluminum is left in contact with a dissimilar metal, its surface will soon be corroded by the resulting electrolytic action.

The general classes of store front metals used by the glazier in providing fastening complexes to hold the glass in place are as follows:

- Entrances, including doors, door frames, and thresholds
- Sash
- Window frames (jambs, heads, sills)
- Division bars and H bars
- Brake shapes
- Mouldings
- Box tubes and split tubes
- Muntin and mullion bars

Store front metal is usually delivered to the shop and is then taken to the job on the company truck, although it can be delivered directly to the job if that is practical. The stock length of most store front metal is 21 ft., a length that seems to make for the least waste when used in fronts constructed in accordance with current building practices.

Preliminary Work

Before the actual work of installing the store front can be started, two preliminary steps must be taken: first, the job must be checked to ensure that the necessary materials are at hand and that openings are as described in the working drawings or blueprints; then the metal must be cut, in accordance with the cutting list.

Checking the job. The first things the glazier must do when the metal arrives on the job is unwrap the stock lengths and check to be sure that the right types of metal have been delivered, in the right quantities.

After checking the metal over, the glazier must examine the openings, following the shop drawings or manufacturer's blueprints sent with each assignment. Shop drawings usually represent details of a building, drawn so that the mechanic in a particular trade will have all the information he needs to fabricate and assemble the materials he works with. These drawings are taken from the architectural drawings included in the master blueprints. The subcontractor in each trade may prepare detailed shop drawings to help his workmen lay out their jobs. However, the glazing contractor often follows the procedure of taking the appropriate drawings off the master blueprints and sending these to the manufacturer when he orders the metal; the manufacturer then sends the necessary detail drawings along with the order. These drawings must be followed as closely as possible, since they are approved by the architect. The working drawings in Unit D are representative of shop drawings.

Each opening must be measured, allowing for the proper clearance. Then the drawings must be checked for the type of metal that is to be used in each position. Many different designs of metal may be used in a given opening. The frame members that are installed to hold doors and glass are manufactured in

many different sizes, ranging from 1-3/4 in. x 3 in. in section up to 2-3/4 in. x 9-1/2 in. The most widely used sizes are 1-3/4 in. x 4 in. and 1-3/4 in. x 4-1/2 in.

Cutting the metal. A cutting list designating the cuts to be made out of each length of metal is sent along on each job. This list must be followed as closely as possible.

One of the most important tools for store front work is the power saw. A table saw may be used for cutting the metal to length and for cutting miters, but a radial arm saw (cutoff saw), which cuts as the blade is pulled through the material, has more power and is used exclusively by many glaziers. Because of its method of operation and its greater power, it can cut stock lengths of material with less tendency to bind the saw blade. The saw blade should be kept well waxed when metal is cut; the wax serves both to lubricate the blade and to keep it sharp longer. If a power saw is not available, the metal can be cut with a hack saw and a metal-cutting miter box.

Store front metal is manufactured for use with many types of glazing materials; the design possibilities are almost limitless. Considerations of design are important, of course, but frequently the determining consideration is price. The prices of different types of store front members vary widely, and the savings obtainable by using the cheaper types of construction are considerable.

Methods of Store Front Installation

Some glaziers prefer to start all store front installation from the left side of the building. Others find it more convenient to vary the beginning point in accordance with the type of installation.

Heads, jambs, and sills. The perimeter of the opening may or may not be fitted with head jambs, side jambs, and sills. (See the working drawings in Unit D for representative details.) If these are not used, the opening may sometimes be lined with brake metal. In many cases, however, the sash or other type of metal holding the glass at the bottom may be placed directly on the masonry or wood.

Sash and division bars. Many store front frames consist entirely of sash and division bars. In such an installation, the gutter of the sash is placed first. The surface against the opening is caulked; this is particularly necessary if the sash is to rest directly on the opening without sills, jambs, or brake metal. Typical screw-set store front sash details are shown in Fig. H-11.

The division bars are put into position as soon as the sash gutter has been placed. Three different parts may be included in a division bar: the stiffener, the spring member, and the face. Some bars consist of only a spring member and a face. Other bars have no spring members; the stiffener is made of aluminum and is shaped to receive the glass directly. The stiffener is used to support the division bar and the glass against wind loads. If the stiffener is made of steel, it has been coated to retard electrolysis at points where it will make contact with the aluminum extrusions. However, some glaziers also

coat the cut edge of the stiffener where it fits against the sash with a bituminous paint that serves the same purpose.

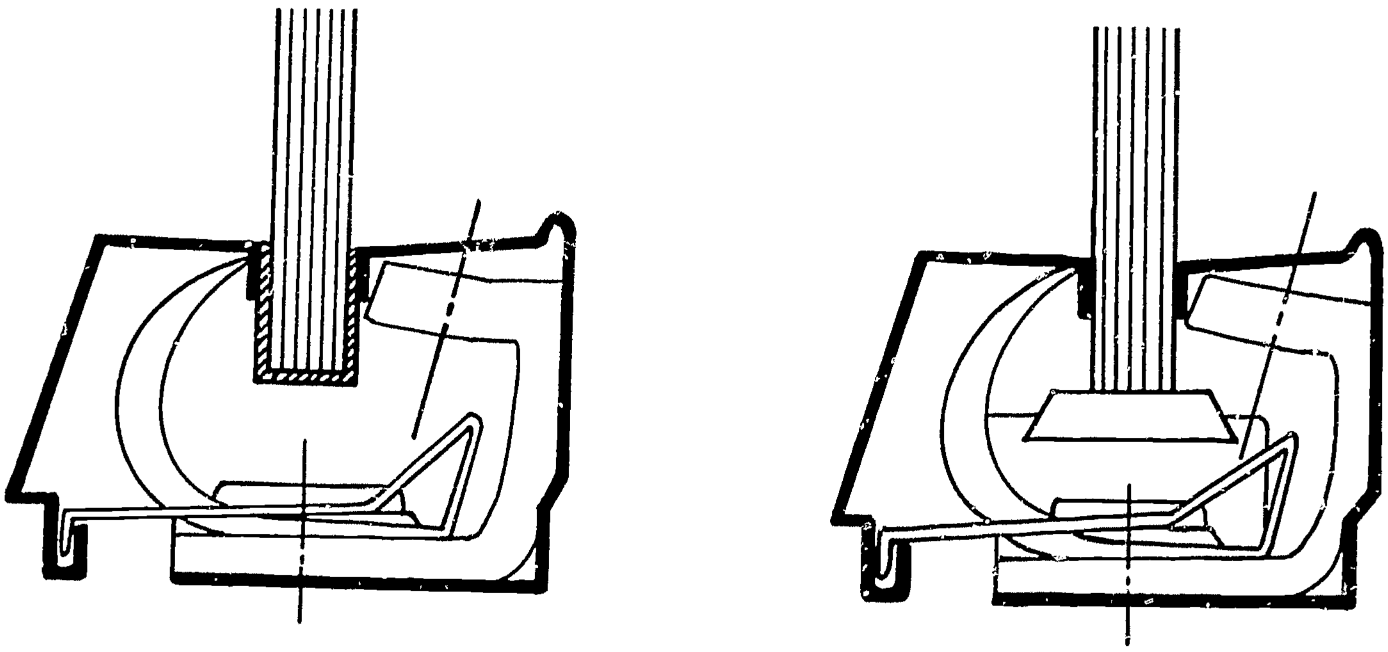


Fig. H-11. Screw-set store front sash (typical details)

The parts of the division bar are cut at the top and bottom to fit flush with the sash, thus providing a solid backing for the glass. Anchors are installed at the top and bottom for greater strength. The face is installed last, fastened by screws that go through the stiffener and into clips contain .' in the face of the sash. Care must be used in tightening the clips; if the screws are too tight, the glass will break when it expands. Screws must be tightened evenly all around.

Flush glazing sash, which may be used on three sides of an opening, is usually installed in two sections (Fig. H-12). The first section is used by the plasterer as a plaster ground. After the plasterer has done his work, the glazier installs the finish metal into the channel that has been recessed into the plaster. The gutter of the sash contains the adjustment screws, which are tightened down on the clips that hook into the face metal and hold it in place.

Half sash is used chiefly where the glass is installed against a wood back stop (Fig. H-13). The back stop is puttied, and the glass is pushed tight against the putty for a seal. The face sash is applied to hold the glass in place. Proper clearance must be allowed below the glass for passage of the screws that go through the face of the sash and into the wood. Cutting the glass so it fits too tightly can result in breakage as it expands with exposure to heat.

Muntin and mullion installation. Another popular type of store front construction consists entirely of muntin and mullion tubes. This is primarily a flush glazing system, and sash is not ordinarily used. The opening may or may not be lined with brake metal. The tubes around the opening are anchored to the perimeter with screws and sealed off with caulking. Weathering clips are screwed into the vertical mullions to provide the connections for the horizontal muntins. Caulking is applied around these clips. The muntins are installed over the clips and screwed down tight.

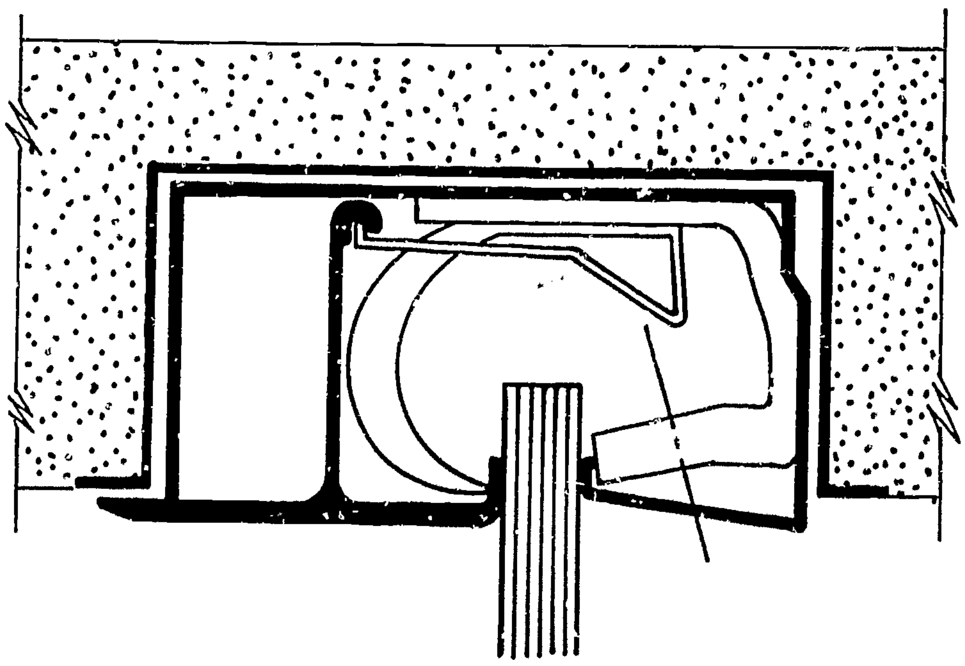


Fig. H-12. Flush glazing channel and sash

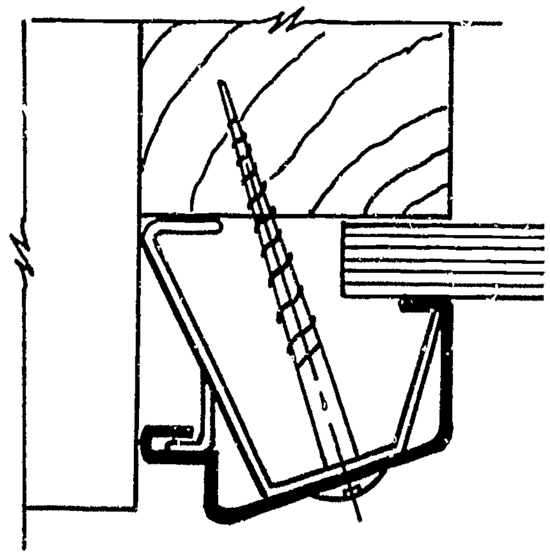


Fig. H-13. Face-set half sash

Unless they must be split to provide expansion joints, mullions are constructed in one piece, with glazing pockets down each side. Muntins may be made in one, two, or three pieces. One-piece muntins have pockets similar to those in mullions. Two- or three-piece muntins include face pieces that snap on one or both sides of the glass after the glass has been set. The glass fits into the pockets in the sides of the mullions, one pocket usually being deeper than the other. The glass is first inserted into the deeper pocket, then swung into the shallow pocket. After the glass has been inserted, the coverage on both sides is equalized. Muntins and mullions may also be glazed with glass stops and vinyl. Steel reinforcing is used in muntins and mullions surrounding doors; in some instances, all muntins and mullions may be reinforced.

When the last piece of metal is ready for installation in muntin-and-mullion construction, the vertical mullion and the horizontal muntin are usually installed as one piece. This is done by cutting the last mullion and holding it temporarily in position against the jamb while the horizontal muntin is measured and cut. After the metal is cut and the burrs are filed off, the muntin is drilled and countersunk, ready for installation. It is rested on the clips on the last mullion already in place and on the mullion to be attached to the jamb, which is still loose but to which anchors have been applied. Then the whole section is pushed into place, with enough clearance to fit. The muntin is screwed into the mullions, and the last mullion is anchored to the jamb and sealed off with caulking.

Bulkheads. Bulkhead material usually comes in two pieces. The first piece is installed hard to the floor. (See detail No. 3 on Plan 9 of the working drawings, Unit D.) If the bulkhead is to be installed on concrete, a masonry drill, star drill, or powder-actuated tool is used to make holes, which are then plugged with plastic or rawlplugs. Screws are used to fasten the bulkhead down. Caulking is always used under bulkheads to make a complete seal. The material is fastened to vertical frame members with angle clips.

The material used for the upper half of the bulkhead is usually designed to slip down over the bottom half and clip into place. If it is desired to have the finished product end at the same height all the way across the store front, it will be necessary for the height of the top of the upper half of the bulkhead to match the height of the glass stop on the door. However, since many modern doors have narrow bottom rails, it is not always possible to achieve this.

If the bulkhead is to be covered with some material, such as tile or structural glass, but there is a need to cover structural members below the opening, a metal sill or bulkhead sash may be used instead of regular sash. Bulkhead sash has an extension that goes below the sill, providing sash and a wide decorative covering in one operation. Companion pieces of the same design as the bulkhead sash can be purchased if it is necessary to extend the covering beyond the opening.

Other types of store front installations. One of the important characteristics of store front construction is the great number of design variations that are possible; the installations discussed above are only a few of those most commonly found in store fronts. For instance, a type of division bar called a mullion bar may be used instead of the conventional three-piece division bar. (See detail No. 11 on Plan 3 of the working drawings, Unit D.) Finned box tubes--tubes having narrow fins extending from each side--may be used; glass stops are applied below the fins, and the glass rests between the stops and the fins. Split tubes also require glass stops. Sash may be used with any of these bars and tubes, and even with conventional muntin-mullion construction, if desired.

Many miscellaneous mouldings are used in store front work. These may cover expansion joints, seams, or large unfinished areas, such as canopy fronts or areas surrounding special display cases. If no mouldings or facings are available to solve a particular problem, brake metal may be purchased and shaped to fit. Some glazing shops have metal brakes available and do their own bending; others send the metal out to a sheet metal shop, accompanied by shop drawings to show the bending needed. Shaping may also be special-ordered from the factory supplying the metal.

Wall systems. Factory-fabricated unit walls, often referred to as curtain walls, are employed in many types of construction. The walls are attached to the floors with angle anchors and leveling clips. The anchors can be placed most easily and rapidly by means of a powder-actuated tool. The horizontal rails and the mullions are joined together by concealed fasteners that make the joints especially neat. The mullions are usually split to provide for expansion joints.

Unit walls are glazed after installation. The type of glass stop used is interlocking and requires no exposed screws. Vinyl is used in one continuous run, and the glass is installed from the inside; thus no swinging scaffold is required. If the glass is contained in operable sash, the hardware is made of stainless steel or some other corrosion-resistant material, and it is adjustable so that the windows may be held open in any desired position.

Spandrels and other architectural panels may be employed in conjunction with glass panels for the construction of store fronts as well as for window-wall and curtain-wall multistory building faces. These architectural panels are usually glazed into the frame on the job site, but they are sometimes pre-installed in the shop.

Fastening Devices

Fastening devices--screws of various types, clips, toggle bolts, powder-driven fasteners, and the like--play an important part in store front work and in glazing installations in general. By selecting the right fastener for the job, the glazier can save time and money and make an installation that is both sound and attractive.

Screw sizes. The diameter of a screw may be described by a number or by its appropriate fraction of an inch. For machine screws of less than 1/4 in. diameter, the size is usually designated by a number. From there on, as the size increases, the diameter usually is described by the actual diameter dimension. The diameters of sheet metal screws, however, are designated entirely by number, with numbers ranging from 1 to 14; wood screw diameters are also designated by number, 1 to 24. The larger the number, the larger the screw diameter.

The number of threads per inch is included in the descriptions of machine screws and bolts. Self-tapping screws such as sheet metal screws do not have to be fitted into a threaded hole, and therefore the number of threads per inch is not usually included in the description; this is also true of wood screws.

The length of a screw is always designated by its actual length dimension. The size of a machine screw of 1/4 in. diameter, with 20 threads to the inch, and a length of 1 in. would be described as follows: 1/4 in. x 20 x 1 in. The size of a certain small sheet metal screw 1/4 in. long could be described as 4 x 1/4 in.; the size of a certain large wood screw 1-1/2 in. long could be described as 18 x 1-1/2 in.

Since the numbers representing screw diameters are arbitrary and must be memorized to be useful, many mechanics find it preferable always to specify the actual diameter dimension desired. If he does this, then the mechanic does not run the risk of making a mistake in the number and getting the wrong diameter.

Powder-driven fasteners. On store front installations, glaziers use many powder-driven fasteners of the types discussed in Unit E of this workbook. These fasteners are particularly useful for anchoring door and window frames to concrete, and they are also used extensively in curtain-wall construction.

Door Closers

Door closers of many types are installed in store fronts. The types commonly used range from concealed floor or header closers to units for exposed surface installation. Some closers are manually operated, but many in modern installations are automatic.

Manual door closers. Manual door closers, whether concealed or exposed, overhead or floor type, operate by a combination of spring and hydraulic action. In a typical closer, the Pittco checking floor hinge shown in Fig. H-14, the initial fast closing speed and the final slow checking speed are adjustable with the door in place by means of slotted control screws.

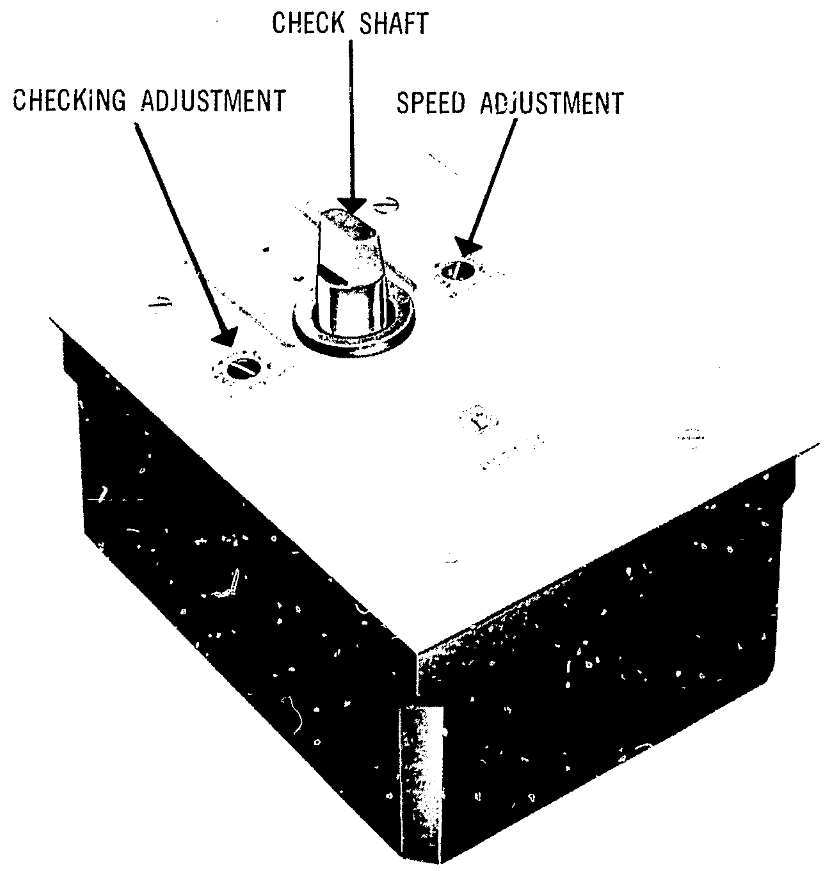


Fig. H-14. Pittco checking floor hinge

Floor closers are not difficult to install. They come complete with a "cement case," a metal housing that must be cemented in place in a pit in the floor. The closer can be removed from the cement case in the event repairs to the mechanism are required. Since mistakes made in the installation of a floor closer are not easily corrected, the mechanic must take extra care in every phase of the operation to ensure that the cement case and the hinge will be correctly located and aligned in the pit when the job is completed.

Manufacturers of floor closers provide detailed installation instructions with their products. An installation template for the Door-O-Matic 260 M series floor closer is shown reduced in size in Fig. H-15. In placing a floor closer with a manufacturer's installation template, the glazier must be sure he is using the correct, up-to-date template for the closer at hand; a template that was supplied with a unit of the same make but of earlier manufacture might not be suitable for the installation of the new closer.

The template shown in Fig. H-15 contains much information of value to the glazier in the installation of the manufacturer's floor closer. It locates the pivot and screw centers for installation both with a dress plate and with a threshold, and indicates the correct depthing of the cement case for both modes

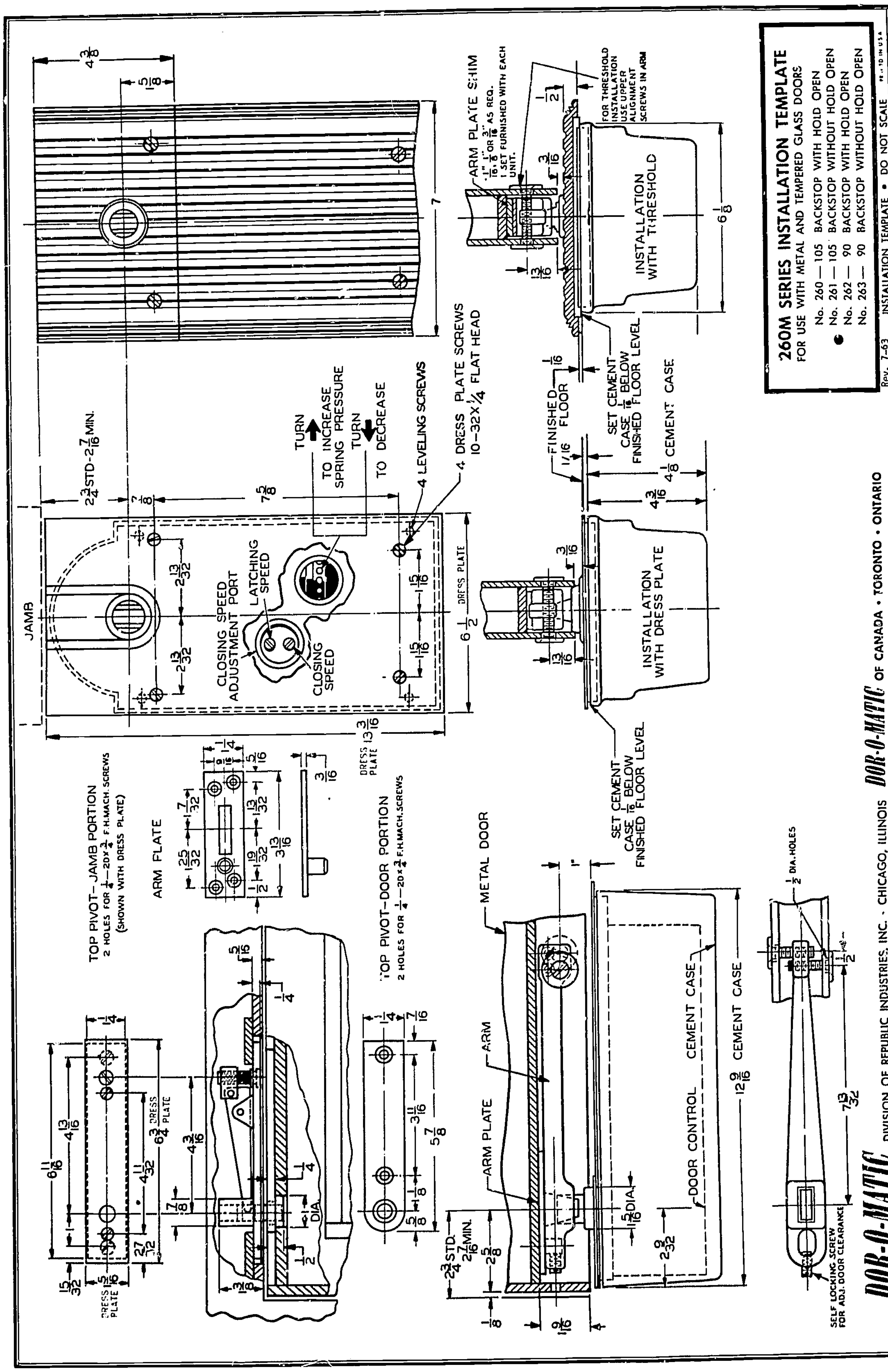


Fig. H-15. Floor closer installation template

of installation; it indicates the distance from pivot center to jamb face, as well as other dimensions and clearances that must be taken into account in the installation; and it locates and identifies the closing-speed and latching-speed adjusting screws and the spring-tension adjusting nut.

The Rixson "Checkspotter," an adjustable fixture that simplifies the installation of Rixson floor closers, is shown in typical application in Fig. H-16.

The fixture, which includes a built-in bubble level, is attached to the closer and cement case as shown, and the closer and fixture are set over the pit in the floor. Shims are employed if they are needed. The leveling screws are then adjusted to provide correct depthing and leveling of the closer assembly. Next, the fixture and attached closer and case are removed from the pit and carefully set aside, and a small quantity of quick-set grout is troweled into the pit. The closer-and-fixture assembly is then replaced in position over the floor pit, and final leveling and alignment corrections are made. The quick-set grout should cover the bottom inch of the cement case. After the grout has set up, the fixture is removed from the closer, and regular grout mixture is added over the quick-set grout and allowed to harden. This completes the installation of the closer into the pit.

An overhead concealed door closer (Jackson No. 20-330) is shown with associated hardware for a center-hung door in Fig. H-17. The Jackson unit shown can also be installed as a floor closer (Jackson No. F20-330). In the overhead installation, the closer is mounted within the header, the arm being installed in the top rail of the door. A removable clamp secures the arm to the square stub shaft of the closer. If the adjustable center-hung bottom pivot shown is used in the door installation, lateral clearance may be adjusted with the door in place; if either the type B or the type E pivot is used, the door must be removed for lateral clearance adjustment. The adjustable pivot assembly is available for either flush or threshold mounting.

The Rixson type 808 door closer (not shown) is another unit representative of the overhead concealed, nonhanded (double-acting) type. This closer is similar in general appearance and application to the Jackson unit described above. Either closer will fit into a 1-3/4 in. x 4 in. aluminum header, and either can be ordered with a choice of spring capacities for light, regular, or heavy door loads. Each closer is available with or without a hold-open feature and with a specified angular degree of opening to positive stop. Closing speed is independently adjustable for each direction of door swing in the Rixson closer; initial closing speed is factory-set in the Jackson closer, but provision for field adjustment of checking (final closing) speed is made.

If a transom is included above an entrance having a concealed closer, the door must be center hung. A door stop may be applied to the transom in the event single action only is desired.

An exposed-type overhead closer is installed to the door and to the frame header or transom header. If necessary, soffit brackets may be used on the header. The exposed closer ordinarily must be installed a specified distance away from the jamb, allowing for the full opening of the door. A template is

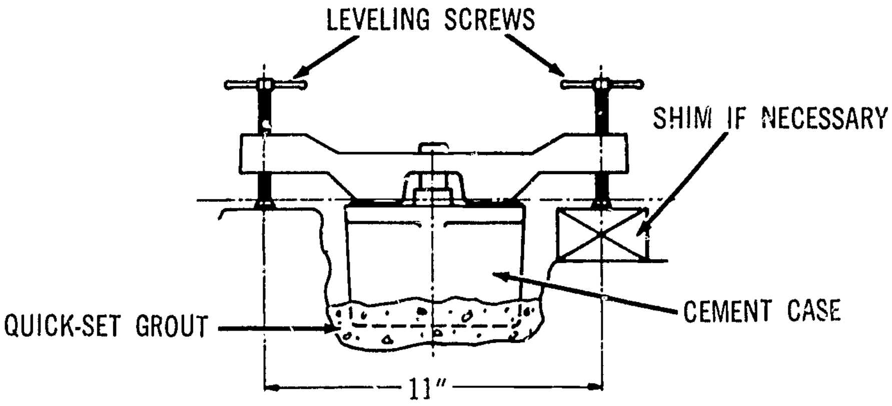


Fig. H-16. Setup of Rixson "Checkspotter" fixture

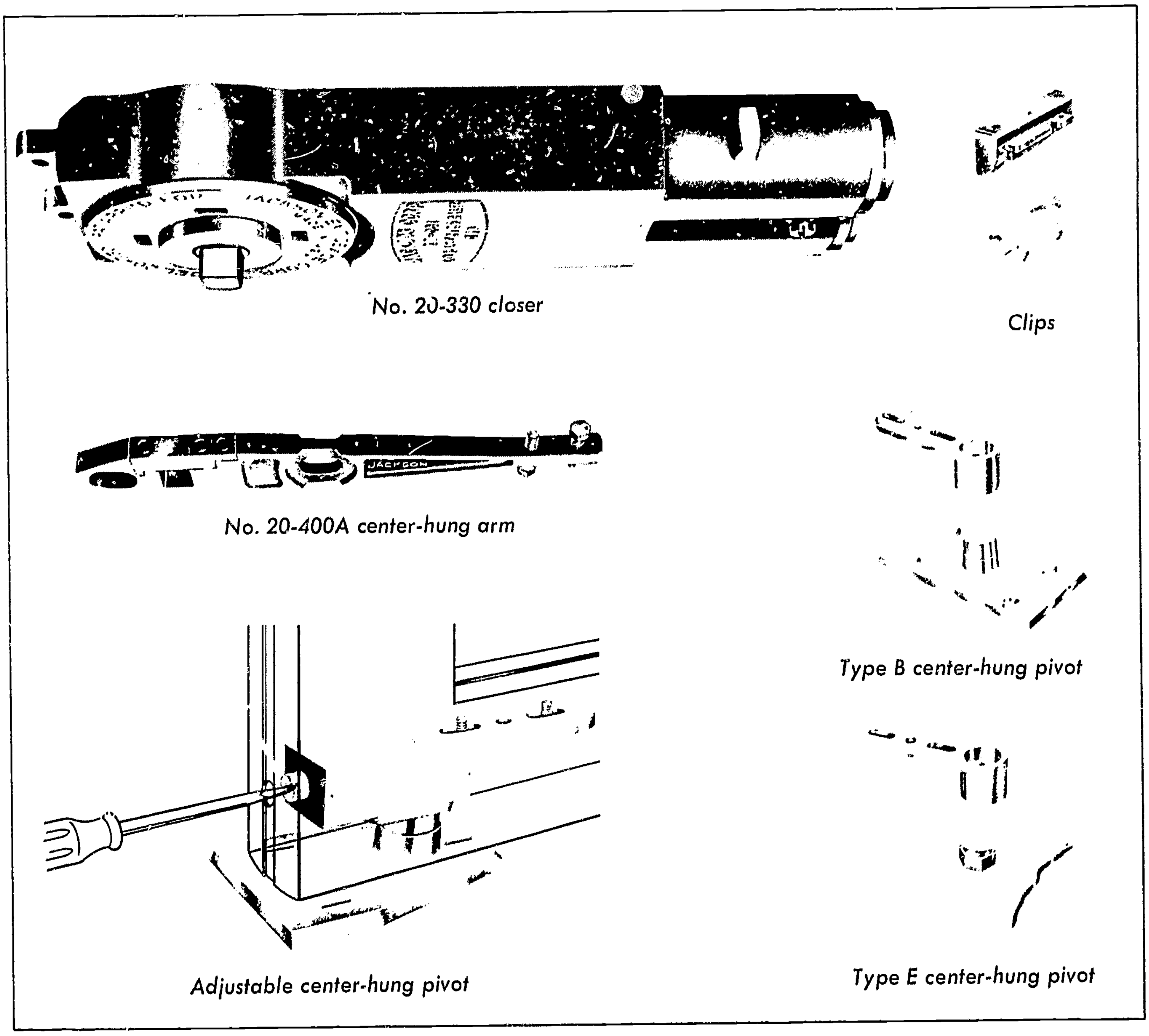


Fig. H-17. Jackson No. 20-330 closer and associated hardware

included with the unit to permit easy location of the mounting screws, which are usually 1/4 in. x 20 or 12 x 24 machine screws. Exposed closers are adjusted from either the top or the side, depending on the style of the unit; a special tool supplied by the manufacturer is employed for the adjustment.

Automatic door closers. Automatic doors are operated by powered overhead or floor-type closers. The closer is commonly actuated by pressure on a floor mat, the actuating mat being the one on the side that is away from the direction in which the door opens. The mat on the side toward which the door opens is called the safety mat. So long as pressure is exerted on the safety mat, the door will not operate.

Automatic door closers may be set up for door-handle actuation rather than mat actuation. An advantage of the handle-actuated installation is that the door or doors can be double acting.

The components of one type of automatic floor closer, the Dor-O-Matic "Invisible Dor-Man," are shown in Fig. H-18. The unit shown is a dual operator for a pair of doors. The photograph shows only one of the four mats required for the dual installation.

The hinge of an automatic floor closer is operated by hydraulic pressure from the power unit, which is basically an electrically powered and electrically actuated compressor. Hydraulic lines cannect the power unit to the floor hinge (or hinges, in the case of the dual unit shown). This type of closer usually requires a large floor pit to house the power unit, but some installations permit the unit to be located as much as 50 ft. away from the entrance. An electrical impulse from the floor mat or door handle starts the compressor, and the resulting hydraulic pressure operates the hinge. The operating speed and hold-open time of an automatic door are set in a control box that contains a timer.

Both manually operated and automatic doors may incorporate a safety feature for the protection of hands that might get caught between the door and the frame; this consists of a 1-in.-wide rubber spacer strip attached to the frame in the region where the pressure of the door would offer the greatest hazard to hands.

The concealed overhead type of automatic closer is an all-electric device having no compressors, hydraulic systems, or restoring springs. The closer is installed into the header with screws, and it can be removed and replaced in less than 10 minutes. Switches on the jamb permit the door to be set for automatic or manual operation or to be held open. If an electric closer becomes defective, it should be sent to the factory for repair.

Study Assignment

Examine catalogs and sales literature describing store front metal, fastening devices, and manual and automatic door closers. (This material will be found in the classroom library.)

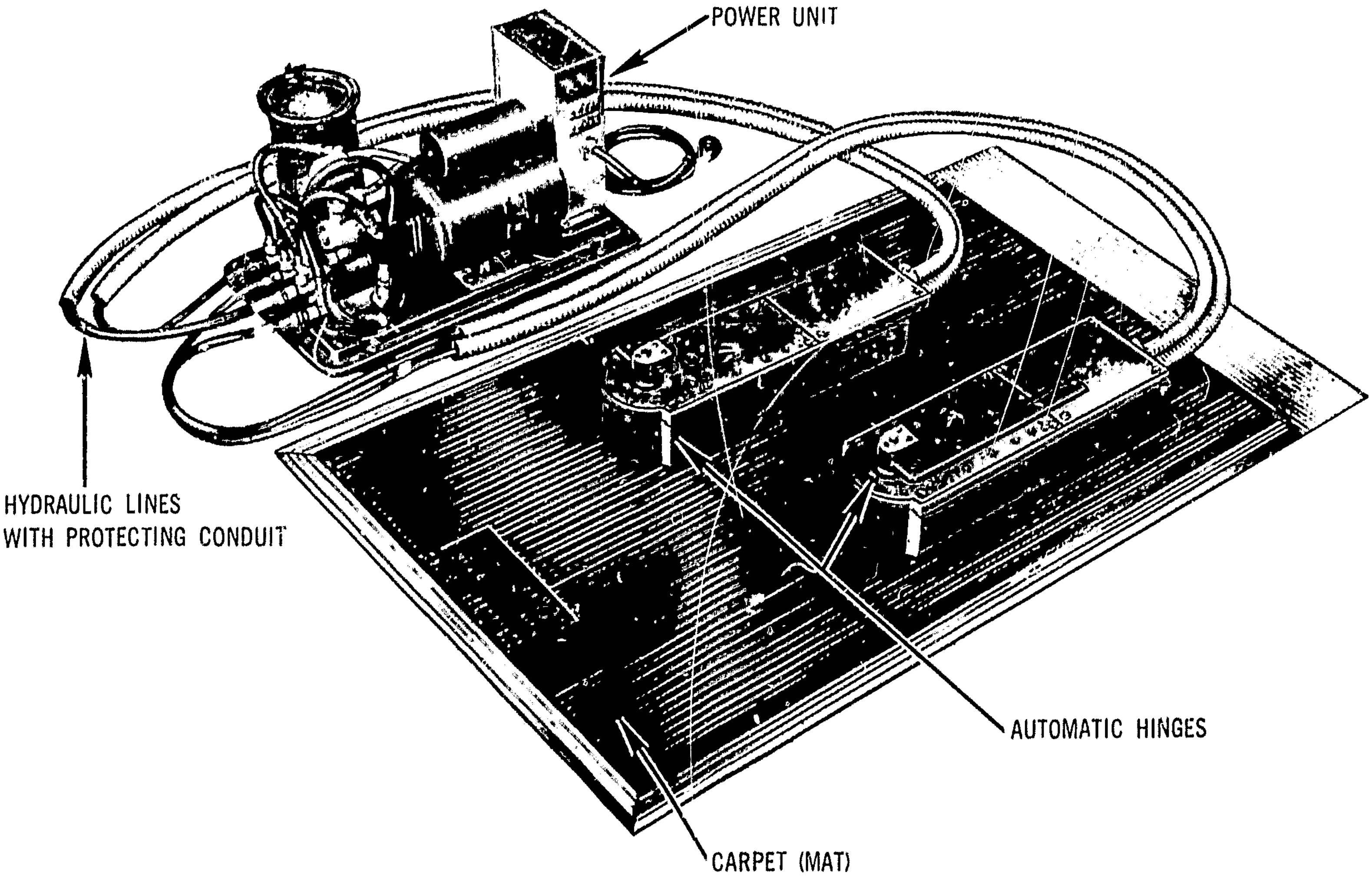


Fig. H-18. Dor-O-Matic "Invisible Dor-Man" dual floor closer

UNIT H--INSTALLATION

TOPIC 6--STORE FRONTS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Store front metal serves two basic purposes: it __1__ the installation of __2__, and it adds to the __3__ of the building on which it is used.	1. ______ 2. ______ 3. ______
2. Most store front metal is manufactured by the __4__ process.	4. ______
3. The danger of corrosion from __5__ __6__ exists whenever aluminum is placed in contact with certain other metals at places where __7__ is present.	5. ______ 6. ______ 7. ______
4. Before the actual work of installing the store front is begun, the job must be __8__ and the metal must be __9__.	8. ______ 9. ______
5. Store front metal is cut in accordance with a(n) __10__ __11__.	10. ______ 11. ______
6. Many store front frames consist entirely of __12__ and __13__ bars.	12. ______ 13. ______
7. The three parts that may be included in a division bar are the __14__, the __15__ member, and the __16__.	14. ______ 15. ______ 16. ______
8. After the glass is inserted in a muntin-and-mullion framed opening, the glass coverage is __17__.	17. ______
9. Mouldings are used in store front work to cover __18__ joints, __19__, or large unfinished areas such as __20__ fronts.	18. ______ 19. ______ 20. ______
10. If a transom is included above an entrance having a concealed closer, the door must be __21__ hung.	21. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Shop drawings are taken from the specifications.	1.	T	F
2. Plastics are sometimes used in the glazing of store fronts.	2.	T	F
3. The installation of metal is usually started from the right side of the store front.	3.	T	F
4. Bulkhead sash is sometimes used as a substitute for a separate sill.	4.	T	F
5. Division bar stiffeners may be made of steel or aluminum.	5.	T	F
6. Unit walls are fabricated on the job.	6.	T	F
7. A manual overhead concealed door closer operates by means of a combination of electricity, springs, and hydraulic pressure.	7.	T	F
8. The cement case must be removed to repair a floor closer.	8.	T	F
9. Floor closers require more precise installation than overhead closers.	9.	T	F
10. The greatest depth dimension found in regular store front metal is about 6 in.	10.	T	F
11. When sash is used in a store front, division bars must be used for the vertical members of the framing.	11.	T	F
12. A table saw may be used for cutting miters.	12.	T	F
13. Stiffeners must be attached to division bars.	13.	T	F
14. Price is often the controlling factor in the choice of store front metal.	14.	T	F
15. Flush glazing installations require the use of sash.	15.	T	F
16. Half sash is used chiefly against wood back stops.	16.	T	F
17. Muntin-and-mullion construction requires the use of sash.	17.	T	F

18. Mullions are usually constructed in one piece.	18.	T	F
19. The number of threads per inch is included in the description of a machine screw.	19.	T	F
20. A swinging stage is used when unit walls are installed.	20.	T	F
21. Unit walls are installed by means of anchors.	21.	T	F
22. Weathering clips are used with muntins and mullions.	22.	T	F
23. Overhead concealed door closers are installed by means of soffit brackets.	23.	T	F
24. Door closing speeds are usually set in two stages.	24.	T	F
25. Automatic door closers are commonly actuated by pressure on a floor mat.	25.	T	F

UNIT H--INSTALLATION

TOPIC 7--STRUCTURAL GLASS

This topic, "Structural Glass," is planned to help you find answers to the following questions:

- Where is structural glass used?
- How is the backing prepared to receive structural glass?
- How is the structural glass installed to the backing?

The special characteristics of structural glass determine its range of uses. It is not harmed by moisture or stains, and it does not pick up odors; it can therefore be used where sanitary conditions must be maintained, as in restaurants, hospitals, laboratories, and food processing plants. However, the widest use for structural glass is in store fronts. It can be used for fascia, pilasters, bulkheads, and other structural members to make up an all-glass front.

Structural glass is not used as widely today as it was a few years ago, even in store fronts; however, the glazier must still know how to install it, for he may be required to do so at any time.

Cutting and Fabricating the Glass

Structural glass comes in sizes up to 72 in. x 132 in. and ranges in thickness from 1/4 in. to 1-1/4 in. The maximum area of any single piece of structural glass to be installed less than 15 ft. above the sidewalk is 10 sq. ft.; if the piece is to be installed more than 15 ft. above the sidewalk, its area must not exceed 6 sq. ft. The maximum length on any one edge shall not exceed 4 ft. These maximums may vary with local building codes.

Structural glass is as easy to work and process as plate glass, but it should never be cut dry. When structural glass is cut, it should be broken as soon as possible, using correct pressure to assure a clean cut. If a hole up to 5/8 in. is needed, a three-cornered drill of the right size may be used. If firm pressure is applied and the drill is well lubricated, the hole will be made easily. For larger holes, a tube drill may be used with the usual carborundum and water mixture for abrasive action and cooling.

Preparing the Backing

Backing for structural glass should be substantial and fireproof. Cement, plaster, tile, brick, concrete, stone, cinder block, and terra cotta are suitable backing materials. If the backing is not rigid, it will be impossible to push the structural glass back to the proper position with assurance that it will remain there. Backing should be built so that no more than 1/2 in.

thickness of mastic is used to hold the glass to the wall. Mastic shrinks slightly in the curing process, and the thicker the gobs of mastic, the more the shrinkage. The use of too much mastic can result in an uneven finished product. Bond coats on the backing prevent it from absorbing the oils that give the mastic its adhesive power and flexibility. One gallon of bond coat covers between 75 and 100 sq. ft. of backing area.

Where glass is applied at a height greater than one story, many local building codes call for the application of mechanical fasteners. These shelf angles must be secured to the backing with drive-in nails, toggle bolts, mollies, lead anchors, or some other approved type of fastener.

Installing the Glass

After the structural glass has been fabricated and is ready for installation, the next step is the application of asphalt mastic. Before the mastic is applied to the back of the glass, the glass surface must be dry; if a moisture film is present, the adhesion of the mastic will be hindered. An electrically heated hand scoop can be used to speed up the application of exterior mastic. The heated scoop makes it easier to remove stiff mastic from the can in cold weather and also forms gobs of the proper size and shape to permit the glass to be worked against the backing until proper adhesion is obtained.

After the mastic has been applied to the back of the glass, the glass is installed by placing it against the backing and moving it up and down, pushing inward at the same time; this flattens the gobs of mastic (Fig. H-19). The result is good adhesion of the structural glass to the backing.

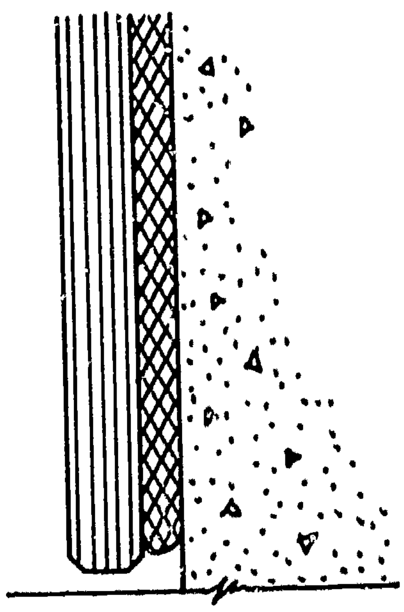


Fig. H-19
Installation of structural glass

When one light of structural glass is to be stacked upon another, the best material for taping the joints is asphaltic cork joint tape, 1/16 in. thick, set back from the edge 1/8 in. The work should be finished by pointing the joints with joint cement and wiping the job down.

UNIT H--INSTALLATION

TOPIC 7--STRUCTURAL GLASS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Structural glass is not harmed by __1__ or __2__, and it does not pick up __3__. — 1. ______ 2. ______ 3. ______

2. An all-glass store front can be produced if structural glass is employed for __4__, __5__, __6__, and other structural members. — 4. ______ 5. ______ 6. ______

3. Structural glass is used not only in store fronts, but also in applications where __7__ conditions must be maintained. — 7. ______

4. Structural glass comes in sizes up to __8__ x __9__. — 8. ______ 9. ______

5. Backing for structural glass should be __10__ and __11__. — 10. ______ 11. ______

6. The maximum area of any single piece of structural glass that is to be installed higher than 15 ft. above the sidewalk is __12__. — 12. ______

7. The use of too thick a layer of __13__ can result in a(n) __14__ finished product. — 13. ______ 14. ______

8. One gallon of bond coat covers between __15__ and __16__ sq. ft. of backing area. — 15. ______ 16. ______

9. The application of exterior mastic is made easier by the use of a(n) __17__ heated __18__. — 17. ______ 18. ______

10. When installing the structural glass onto the backing, the glazier should move the glass __19__ and __20__ while pushing it __21__; this will make for uniform thickness of the __22__ and will ensure good __23__. — 19. ______ 20. ______ 21. ______ 22. ______ 23. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Structural glass is used mostly in store fronts.	1.	T	F
2. Structural glass is harder to work than plate glass.	2.	T	F
3. A moisture film on the back of structural glass will prevent good adhesion of the mastic.	3.	T	F
4. Bond coats on the backing help keep the mastic flexible and adhesive.	4.	T	F
5. The backing for structural glass must be rigid.	5.	T	F
6. Mastic between the structural glass and the backing may be no more than 1/4 in. thick.	6.	T	F
7. Horizontal joints in structural glass should be filled with caulking to a thickness of 1/16 in.	7.	T	F
8. Mechanical fasteners are often required if the structural glass is installed at a height greater than one story.	8.	T	F
9. Mastic is best applied with a putty knife.	9.	T	F
10. Pieces of structural glass may be stacked one above the other.	10.	T	F

UNIT H--INSTALLATION

TOPIC 8--SHOWCASE GLAZING

This topic, "Showcase Glazing," is planned to help you find answers to the following questions:

- What operations are required in showcase glazing?
- What are the main parts of the most common type of showcase?
- What procedure is followed in glazing a wood-and-glass showcase?

Showcase glazing is mainly done in a mill or a cabinet shop. Many times, however, a glazier may be required to replace broken glass in a showcase in the field. Certain standard procedures are followed for showcase glazing, both in the shop and in the field. This type of work offers the glazier a good opportunity to employ his knowledge of fabrication, edgework, and installation.

Showcases are usually made with wooden backs and supports and with glass tops, sides, and faces. The edges of the glass exposed to view are finished by polishing and grinding; this protects the public from injury or harm from sharp edges and gives the showcase a finished appearance.

Glazing a Showcase

When new work is to be done on a showcase having a wooden base and back, the following steps should be taken.

1. Clean out all slots and grooves where glass is to be installed.

2. Cut the two side panels of glass to size. Allow clearance for the front panel to pass in front of the sides, making a lap joint. Swipe the edges that are to be placed in grooves in the wood. Grind the front and top edges of each side panel where cement is to be used; this helps ensure a good bond.

3. Cut the front panel to size. Allow enough length for the front panel to pass by the side panels and form a lap joint. Grind the top edge, and swipe the edge that is to be placed in the wooden groove. Polish the two ends.

4. Set the two end panels and the front panel in place. Use masking tape to hold the three pieces together temporarily.

5. Cut the top panel to size. Use the temporary setting to determine the proper size, which should allow approximately 1/2 in. lap at both the front and the sides. Polish all exposed edges of the top panel.

6. Remove the front panel from its temporary setting. Butter the front edges of the side panels with showcase cement. (Showcase cement is applied directly from the can without being thinned. In some cases, it may be necessary to apply heat to the cement to make it pliable. This may be done by placing the can with the lid removed in a pan of water and then bringing the water to a boil.)

7. Set the front panel in place. Press it into the cement at the joint to form a firm bond. Use masking tape to hold the joints firmly in place.

8. Butter the top edges of the front panel and side panels with cement. Set the top panel in place, press it firmly into the cement, and tape as required.

9. Clean off all excess showcase cement. This can be done by using thinner, being careful that the cement is not weakened or loosened from its seal. After the cement has set approximately 48 hours, remove the masking tape.

In some types of showcases, the wooden back rail is designed to be cemented to the top panel; showcase cement is used to form this joint between the top panel and the wooden back.

With slight variations to allow for design differences, the procedure given above can be used for almost all showcase installations.

UNIT H--INSTALLATION

TOPIC 8--SHOWCASE GLAZING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The edges of showcase panels that go into grooves are __1__.	1. ________
2. The edges to be cemented are __2__, and exposed edges are __3__.	2. ________ 3. ________
3. The joints between front and side panels are __4__ joints.	4. ________
4. The __5__ panel is the last to be installed.	5. ________
5. If showcase cement is not sufficiently pliable to use, it should be __6__ in a pan of __7__ __8__.	6. ________ 7. ________ 8. ________
6. The top panel is cut to size __9__ the front and sides are cemented together.	9. ________
7. Grinding the edges of glass makes the cement __10__ better.	10. ________
8. The back of a showcase is usually made of __11__.	11. ________
9. The lap allowed for on the top panel should be about __12__ at the front and sides.	12. ________
10. Slots and grooves in the showcase framing members must be __13__ before they receive the glass.	13. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	Replacement work accounts for the greater part of the showcase glazing in the field.	1.	T	F
2.	The same standard procedures are used for showcase glazing both in the shop and in the field.	2.	T	F
3.	Showcase cement can be thinned with alcohol if it is not workable.	3.	T	F
4.	Masking tape may be used to hold showcase joints during the setting of the cement.	4.	T	F
5.	Excess cement should be scraped off the glass with a razor blade.	5.	T	F
6.	Showcase cement must set for approximately 48 hours before the temporary joint support can be safely removed.	6.	T	F
7.	Showcase cement is only usable for making glass-to-glass joints.	7.	T	F
8.	Showcase supports are usually made of wood.	8.	T	F
9.	A polished edge makes a satisfactory bond with the cement.	9.	T	F
10.	The front panel of the showcase is cut to size after the side panels have been made.	10.	T	F

UNIT H--INSTALLATION

TOPIC 9--MIRRORS

This topic, "Mirrors," is planned to help you find answers to the following questions:

- What materials are used for the installation of mirrors?
- What precautions should be taken to ensure that mirror stock sheets will not be damaged in storage or during handling?
- How does the installation of a one-way mirror differ from that of a conventional mirror?

The various types of mirrors that have been described in Unit F of this workbook may be installed in a number of ways and with various materials. The method of installation to be used will depend upon the type and size of the mirror specified for the job, the mouldings or trim required, and so forth.

Storing and Handling Mirrors

Mirrors of all types must be stored correctly and handled with great care during installation if damage to the glass surfaces and coatings is to be avoided. The protective film of paint or copper on the silvered back of a mirror is very thin and easily damaged by being marred or scratched. If the protective film is broken, the mirror's reflective silver coating, which in some cases is only 5 millionths of an inch thick, will discolor. The face surface of the mirror must also be protected; any scratch or imperfection will be exaggerated because of its reflection from the silvered surface.

The transparent evaporated-metal coating on a one-way mirror is exceptionally hard and durable, but it is less than one-tenth as thick as the reflective silver coating on a conventional mirror, and it can be damaged through careless handling or incorrect cleaning. Any normal cleaning procedure can be employed provided that no abrasive materials or hard types of cloth are used; mild soap, clean water, and a soft cloth or absorbent cotton are satisfactory.

Stock sheets of mirrors are generally stored in racks, with several sheets leaned in one pile; when mirrors are stored in this way, paper should be placed between the sheets to prevent damage that might result from their rubbing together. It is also good practice to pair the mirrors in the pile with their face sides or their back sides together. When stock sheets are moved about in the racks, they should not be allowed to rub or slide against each other.

Mirror Installation Procedures

Mirrors of all types must be installed so that the glass is not under any strain or tension; if the mirror surface is not a perfect plane, the image it reflects will be distorted. For this reason, good working practices are very important in mirror installation.

Conventional silver-backed mirrors are installed on walls or other backing surfaces by means of clips, wood or metal frames, or mastic, or by some combination of these means (Fig. H-20). One-way mirrors are glazed into openings. The procedures for each type of installation are described in the following paragraphs.

Clips. Clips used for mirror installation may be either plastic or metal. In either case, the following procedure should be employed:

1. Mark the location of the bottom edge of the mirror. Level the line and install the bottom clips, leaving them slightly loose.

2. With the mirror held in place, check the flatness of the wall by sighting along the sides and top to determine if the glass is resting flat against the wall.

3. Fasten the top clip or clips and then the side clips in place, but do not tighten them.

4. Starting with the bottom clips and working around the mirror, tighten the clips evenly to the proper tension. Be careful not to tighten the clips so much that tension is set up in the glass; the mirror should rest freely on the wall, held lightly but firmly by the clips.

Wood frames. Wood frames for mirrors usually consist of wood mouldings. The following procedure should be followed to install a wood-framed mirror:

1. Tack the bottom mould in place, leaving it loose.

2. Set the mirror into the bottom mould groove and tip it back against the wall, checking the setting for twist or tension.

3. Tack the top mould and side moulds in place, leaving them loose.

4. Starting at the bottom, tighten the mouldings around the mirror. Draw them up until the mirror is secure and rests freely against the wall with no twist or tension.

5. Countersink the nails or screws.

Metal frames. Metal frames for mirrors are usually of the concealed-fastener type, and the mirror comes set into the frame. The installation of a metal-framed mirror should be done as follows:

1. Remove the mirror from the frame; then reassemble the frame.

2. Place the frame against the wall in the correct position and check the wall for flatness, blocking out the frame as required.

3. Mark the fastening holes on the wall and attach the frame.

4. Remove the side or top rail of the frame, depending on the installation; slide the mirror in place, then reset the missing rail.

Mastic. Mastic may be used alone or in combination with other installation materials to secure the mirror in place on the wall. In some installations, a piece of channel mould is used at the bottom of a mirror installed with mastic; this ensures a better job, as the weight of the glass is then not borne by the mastic. Large mirrors may have a tendency to shear the mastic if such reinforcement is not provided. To install a mirror with mastic, the glazier should proceed as follows:

1. Check the wall for flatness with a straightedge or string.

2. Apply mastic to the back of the mirror, making allowances for unevenness in the wall by using more or less mastic in given areas as required.

3. Press the mirror against the wall. Exert only enough pressure to seat the mirror in place, making sure that the pressure is evenly applied so that no surface tension or twist will result.

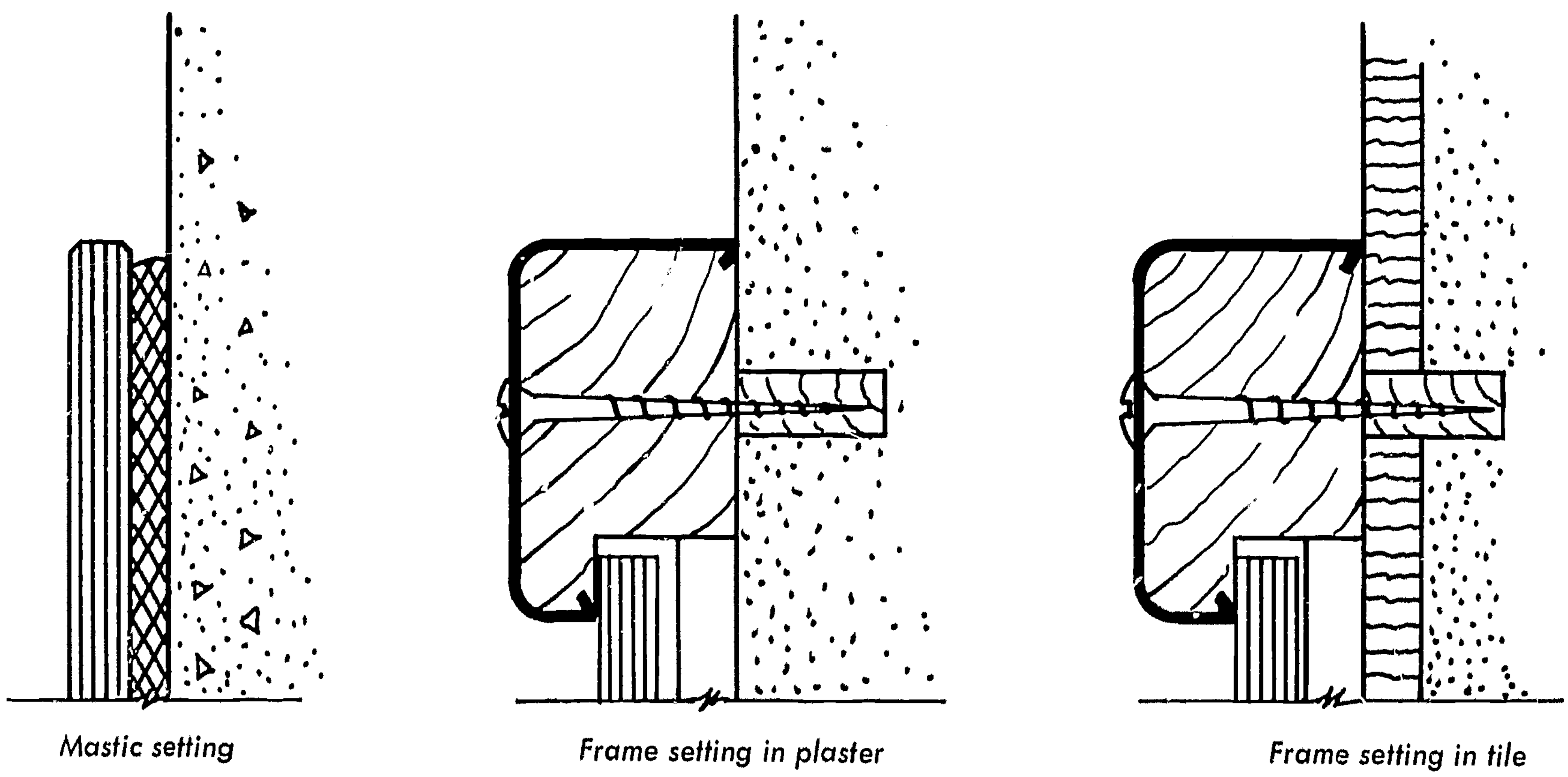


Fig. H-20. Mirror installation

One-way mirrors. A transparent or one-way mirror will not work as intended unless it is correctly installed. It must be glazed into an opening between two rooms, one of which must be kept dimly lighted, the other brightly lighted. The mirror should be glazed with its coated (mirrored) surface toward the brightly lighted room. The coated surface can be identified by placing a pencil point against the glass; if the pencil point is touching the coated surface, the true point and the reflected point will appear to meet.

Before glazing a one-way mirror with putty or glazing compound, the glazier should make sure that the glazing material chosen for use is not a type that could in time damage or spoil the mirror.

UNIT H--INSTALLATION

TOPIC 9--MIRRORS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Mirrors of all types must be __1__ correctly and __2__ carefully.	1. ______ 2. ______
2. The film of __3__ or __4__ on a mirror back serves to protect the __5__ coating.	3. ______ 4. ______ 5. ______
3. The evaporated- __6__ coated surface of a one-way mirror can be cleaned safely with a __7__ cloth, mild __8__, and __9__ water.	6. ______ 7. ______ 8. ______ 9. ______
4. Scratches on the face surface of a silvered-back mirror will be __10__ because of their __11__ images	10. ______ 11. ______
5. The clips used for installing mirrors may be made of __12__ or of __13__.	12. ______ 13. ______
6. If clips are overtightened, __14__ will be set up in the glass.	14. ______
7. Wood frames for mirrors usually consist of __15__ __16__.	15. ______ 16. ______
8. In the installation of a wood frame for a mirror, the __17__ moulding is tacked in place first.	17. ______
9. Metal frames for mirrors are usually of the __18__ fastener type.	18. ______
10. A mirror should be installed so that it is not __19__ or under any __20__ or __21__.	19. ______ 20. ______ 21. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The reflective silver coating of a mirror is in some cases only .000005 in. thick.	1.	T	F
2. Mirror installation may involve a combination of several materials.	2.	T	F
3. When mastic is used for mirror installation, it is wise to use some type of reinforcement to take the weight of the glass.	3.	T	F
4. On a metal frame installation, both sides of the frame must be removed before the glass is inserted.	4.	T	F
5. Stacked sheets of mirrors should be separated by paper to protect their faces and backs from abrasion.	5.	T	F
6. Clips should be fully tightened as soon as they are put in place.	6.	T	F
7. The coating on a one-way mirror is half as thick as the silvering on a conventional mirror.	7.	T	F
8. Any good grade of glazing compound may be used in the installation of a one-way mirror.	8.	T	F
9. A one-way mirror should be installed so that the mirrored surface is toward the brightly lighted room.	9.	T	F
10. Mirrors should be stored in the rack with their face sides always on the left.	10.	T	F

UNIT H--INSTALLATION

TOPIC 10--GLASS REPLACEMENT

This topic, "Glass Replacement," is planned to help you find answers to the following questions:

- How is a broken light of glass removed from wood sash? From metal sash?
- What steps should the glazier take when replacing glass in the customer's home or place of business to avoid marring or soiling floors and furniture in the work area?
- What special safety precautions must be observed in the removal of broken lights of plate glass from store fronts?

The replacement of a broken light of glass presents problems not encountered in new work. The removal of the selvage glass and the preparation of the frame for the new glass can be dangerous if not done correctly. The glazier is often assigned to this type of work, and he should therefore be thoroughly familiar with correct replacement technique to ensure his own safety as well as that of others with whom he may be working.

In general, any broken light of glass, whether large or small, is potentially dangerous to the person removing it, and the danger becomes greater as the size of the glass increases. In every case, the safe removal of the broken light of glass is chiefly a matter of good common sense.

Removing Broken Glass from Wood Sash

Removal of all broken glass before chipping at the putty is especially important in wood sash; back putty often is not used when glass is set in wood sash with a putty facing, and there is thus great danger of prematurely loosening broken pieces of glass by vibration. This falling glass can be a serious hazard to the glazier. If the glass is removed in a shop, the best way is to place the sash over the cutoff barrel, face putty down, and to break the glass into the barrel. If the glass is broken out correctly, part of the putty will stick to the glass and fall out with it.

If the replacement is being done on the job site, a good way to break the glass out is to first make two diagonal cuts across the light. If the sash is in place in the building, the glass should be broken from the inside toward the outside. More cuts may have to be made to get all the glass out.

Any putty remaining in the sash should be removed with a hammer and a hacking knife or chisel, care being taken to work with the grain of the woods. Since wood sash putty is usually thoroughly sealed to the sash, it is likely to take pieces of the sash with it when it is dislodged; this makes it difficult to putty

in a straight line when the glass is replaced and results in a rough-looking job. Goggles should be worn for this operation to protect against flying debris. All putty should be removed from the rabbet. When the sash is thoroughly cleaned, new glass is installed according to the usual procedure for new installation.

Removing Broken Glass from Metal Sash

Replacement of glass in metal sash is seldom done in the shop, but rather is almost always done in the customer's home or place of business. This means that the glazier must be careful to prevent damage to the floor and any furniture or equipment in and around the work area. A small canvas or tarpaulin inside and another outside below the window will usually prevent damage to the floor and outside area. When walking on a tarp, the glazier must avoid tracking dirt, oily residue, or debris onto rugs, cement, flagstone, or other surfaces. If canvas or tarps are not used, the glazier should take care to clean up all slivers of broken glass and other waste around the area he has worked in, particularly in places like rugs and flower beds.

It is advisable to remove as much of the glass as possible from the sash before removing the putty. A hacking knife, chisel, or a small pointed instrument like a screwdriver may be used. Working on the back putty first will tend to force the glass and face putty away from the sash, speeding up the job.

Removing Broken Glass from Store Fronts

The removal of breakage from store fronts presents problems entirely different from those encountered in the removal of breakage from wood and metal sash, chiefly because store front glass is almost always plate glass and large in size. Because no two breakages are alike, no standard method for the store front glass replacement operation can be given; however, the general procedure outlined in the following paragraphs will serve as a guide for the glazier in such work.

Safety is the primary and most important consideration in removing breakage from a store front. In this regard, the first step is to check out and stop runs, giving particular attention to the bottom area of the broken light. Runs are often found there, and these can be especially dangerous. A run can be stopped by cutting a semicircle across the end of the run.

Any broken glass in the corners should be removed first; then the remaining plate should be taken out. The pieces most difficult to remove are plates that are broken completely across in a horizontal line. In such a case, holes may be cut from the break large enough to allow the placement of supporting poles through the glass. The poles will hold the weight of the upper glass while the bottom part is being removed. Finally, the upper glass is removed.

If the glass is broken horizontally more than halfway up, the bottom stop should be removed and a setting block placed to hold the larger bottom piece. The smaller upper piece is removed first, then the bottom piece.

If plate glass has been set in place without putty or compound (dry glazed), there is no firm bond or seal between the glass and the aluminum. In this case, the glass can sometimes be slipped out of the sections very easily. However, this should be done very carefully, one piece at a time. The glazier must be certain that no piece being removed is holding another piece in place. It may be advisable to cut the broken pieces into smaller pieces so that only small sections are removed at a time. Also, the possibility must be kept in mind that all of the pieces may let loose at the same time; the falling pieces of heavy glass would be very dangerous to the glazier and could also damage the store front metal.

Large pieces of plate glass with bullet holes--small holes caused by small, hard objects striking the glass at high speed--must be handled with extreme caution. The glass must be held as nearly perpendicular as possible and must not be allowed to wobble or shake as it is being removed.

UNIT H--INSTALLATION

TOPIC 10--GLASS REPLACEMENT - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The danger involved in glass replacement work increases as the __1__ of the __2__ increases.	1. ______ 2. ______
2. The removal of all broken glass before chipping at the putty is especially important with __3__ sash.	3. ______
3. In removing glass from wood sash in the shop, the best procedure is to place the sash over the __4__ __5__, face putty down, then break the glass out.	4. ______ 5. ______
4. When replacing glass in a private residence or a place of business, the glazier must take care not to soil or damage __6__, __7__, or __8__ in and around the work area.	6. ______ 7. ______ 8. ______
5. If the broken glass is in metal sash, the glazier should first remove as much of the __9__ as possible; then he should remove the putty, working on the __10__ putty first.	9. ______ 10. ______
6. The primary consideration in removing breakage from a store front is __11__.	11. ______
7. Before any attempt is made to remove a broken light from a store front, any __12__ in the glass must be stopped.	12. ______
8. If plate glass has been __13__ glazed, there will be no firm bond between the glass and the aluminum.	13. ______
9. Bullet holes are breaks in the glass caused by __14__, __15__ objects striking the glass at high __16__.	14. ______ 15. ______ 16. ______
10. Where the broken plate glass is in a dry-glazed opening, it may be advisable to cut the broken sections into __17__ __18__.	17. ______ 18. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	A screwdriver is a useful tool for removing putty from wood sash.	1.	T	F
2.	There are essential differences between the installation of glass in new sash and the replacement of glass in old sash that has been correctly prepared.	2.	T	F
3.	Glass is sometimes more dangerous to remove from wood sash than from metal sash; this is so because back putty is seldom used in wood sash.	3.	T	F
4.	The removal of broken glass from a store front is less dangerous if it has been dry glazed.	4.	T	F
5.	Debris stuck to the rabbet or channel can be puttied over when new glass is installed.	5.	T	F
6.	A problem in removing glass from wood sash is that part of the sash may come off with the putty.	6.	T	F
7.	If a large plate has been broken across horizontally more than halfway up, it is best to remove the top piece first.	7.	T	F
8.	If a large plate has been broken horizontally near or below the middle, the top piece should be removed first.	8.	T	F
9.	If the corners of a large plate are broken, the unbroken large pieces should be removed first.			
10.	Supporting poles should be used to hold the upper piece of plate while the lower piece is being removed.	10.	T	F

UNIT I Suspended Glazing

This unit, "Suspended Glazing," is planned to help you find answers to the following questions:

- What is suspended glazing?
- What factor led to the development of suspended glazing?
- How does suspended glazing differ from conventional glazing?
- What are the advantages of suspended glazing?

Suspended glazing is a system of installing large glass by hanging it so that its total weight is carried at the points of suspension above the top edge of the glass; the bottom edge of the glass, which floats in a metal channel filled with spongy material, carries none of the weight. In this and other respects, suspended glazing is totally unlike the standard glazing system.

The extent to which the suspended glazing system will replace the standard system cannot be predicted at this time. However, every glazier should be acquainted with this new glazing technique, for it offers certain advantages over the standard glazing method and may therefore come into wide use in the future.

The suspended glazing system was developed in response to the continuing requirement for larger and larger lights of glass in construction. In the standard method of glazing a large light, the glass is generally set on blocks of wood, lead, rubber, or other firm substance. The blocks are set under the bottom edge of the glass, close to the corners. Thus, all the weight of the glass is carried on the blocks, the surrounding frame serving only to keep the light of glass from bulging and falling out. As a result, there is strain at the blocking points which, together with possible settling of the building, can cause breakage. In suspended glazing, however, the light is held by two clamp assemblies suspended from the ceiling or other overhead structural support; either single clamp or twin clamp assemblies are used, depending on the size of the light to be held (Fig. I-1). Each clamp is locked to bronze plates that are bonded to the glass with epoxy cement. This is done prior to moving the light to the jobsite.

The bottom edge of the glass is held in a metal channel, without setting blocks, to prevent the glass from swinging in the wind. The bottom channel does not give support to the plate; however, it is filled with weatherproof sealant to prevent leakage. The glass plates are butted and bonded together with an epoxy cement. A vertical glass stabilizer is cemented at the joint on each side of the plate at a 90° angle. The stabilizer, which is also suspended, prevents the large lights from bowing in and out (Fig. I-2).

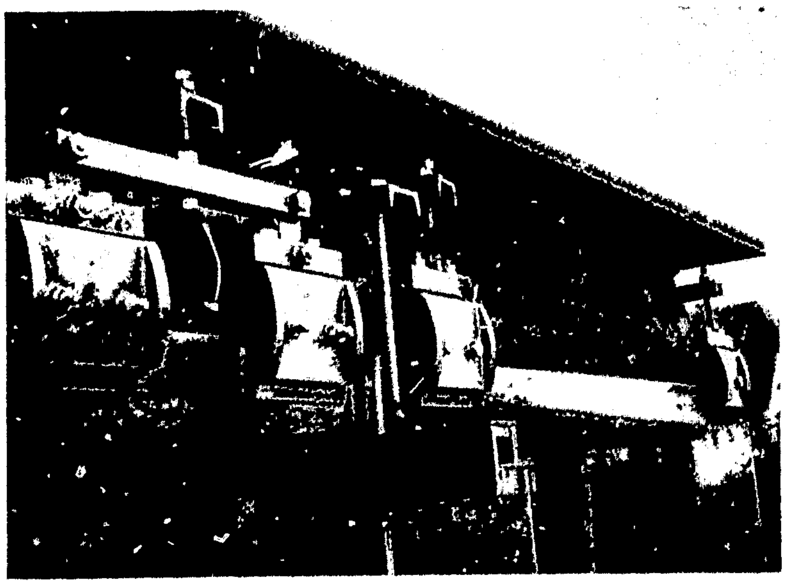


Fig. I-1. Typical clamp assembly details

Among the advantages claimed for the suspended glazing system are the following:

- Glass can be installed without limitation on height, maximum size of the light being dependent only upon manufacturing capabilities.
- Distortion tends to be reduced because the glass hangs straight down in perfect equilibrium.
- The glass is not subject to stresses caused by settlement of the building, for it is suspended like a curtain and is free to move with the structure.
- A safer installation results. When glass breaks in a conventionally glazed opening, it often falls with a guillotine effect; if the suspended glass breaks, the top piece remains in place, held by the clamps.

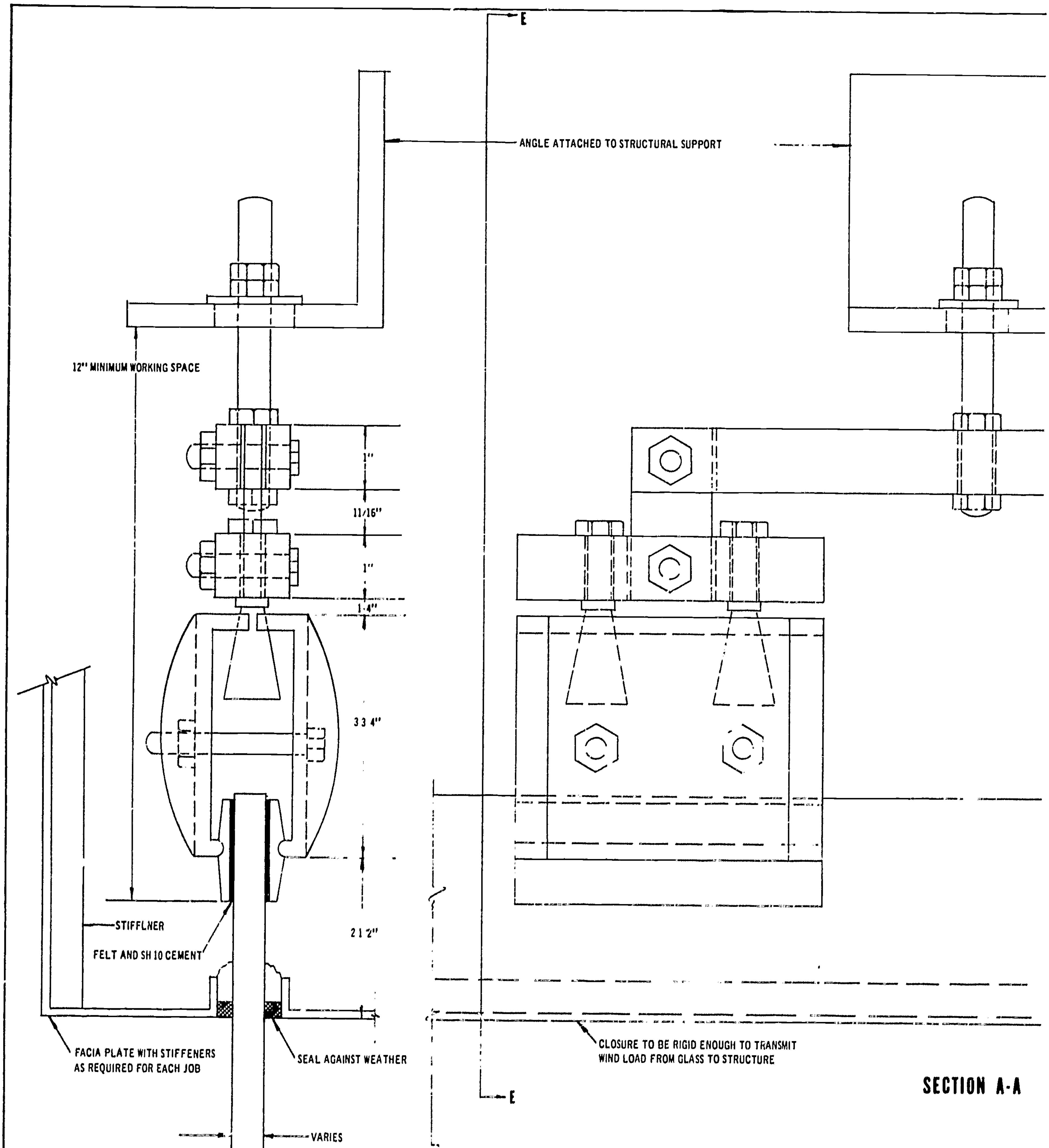
Tests conducted at the University of Miami in 1964 demonstrated that the suspended glazing method makes possible an installation having excellent resistance to wind loads. At the time of this writing, the suspended glazing method has not been tested for earthquake resistance.

The two drawings included in this unit as Plans 11 and 12 show details of the suspended glazing system.

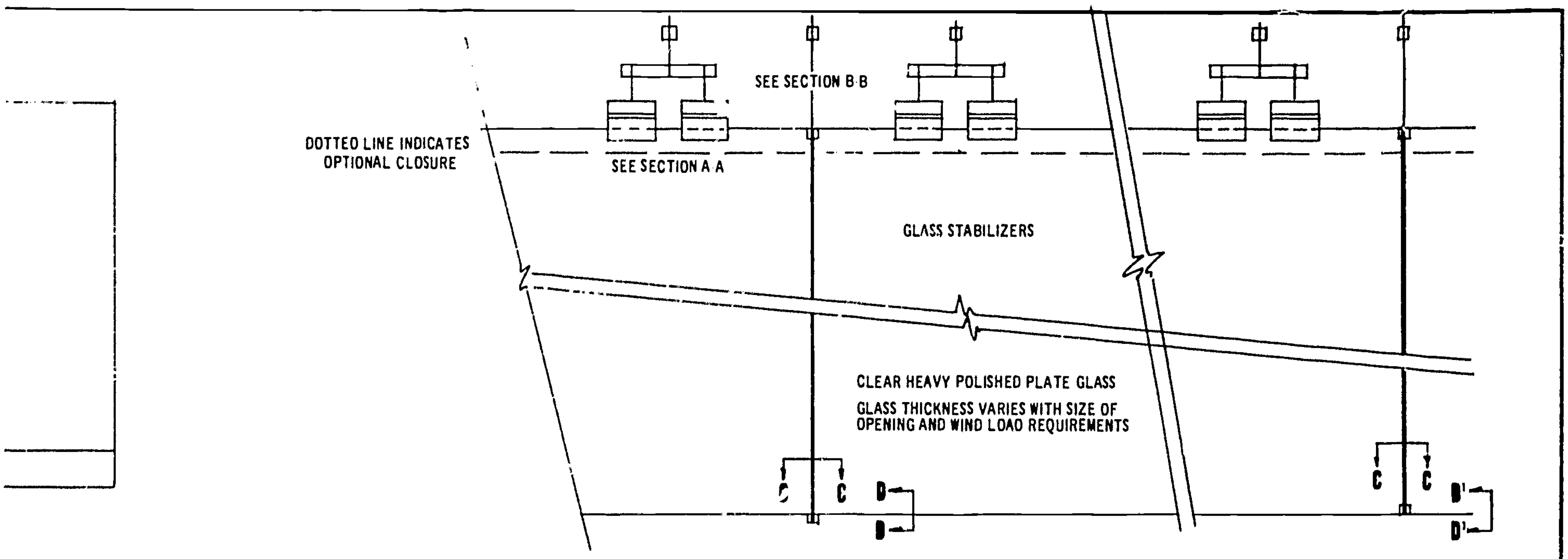
Study Assignment

Glazing Manual. Read the section on suspended glazing, pp. 22 and 23.

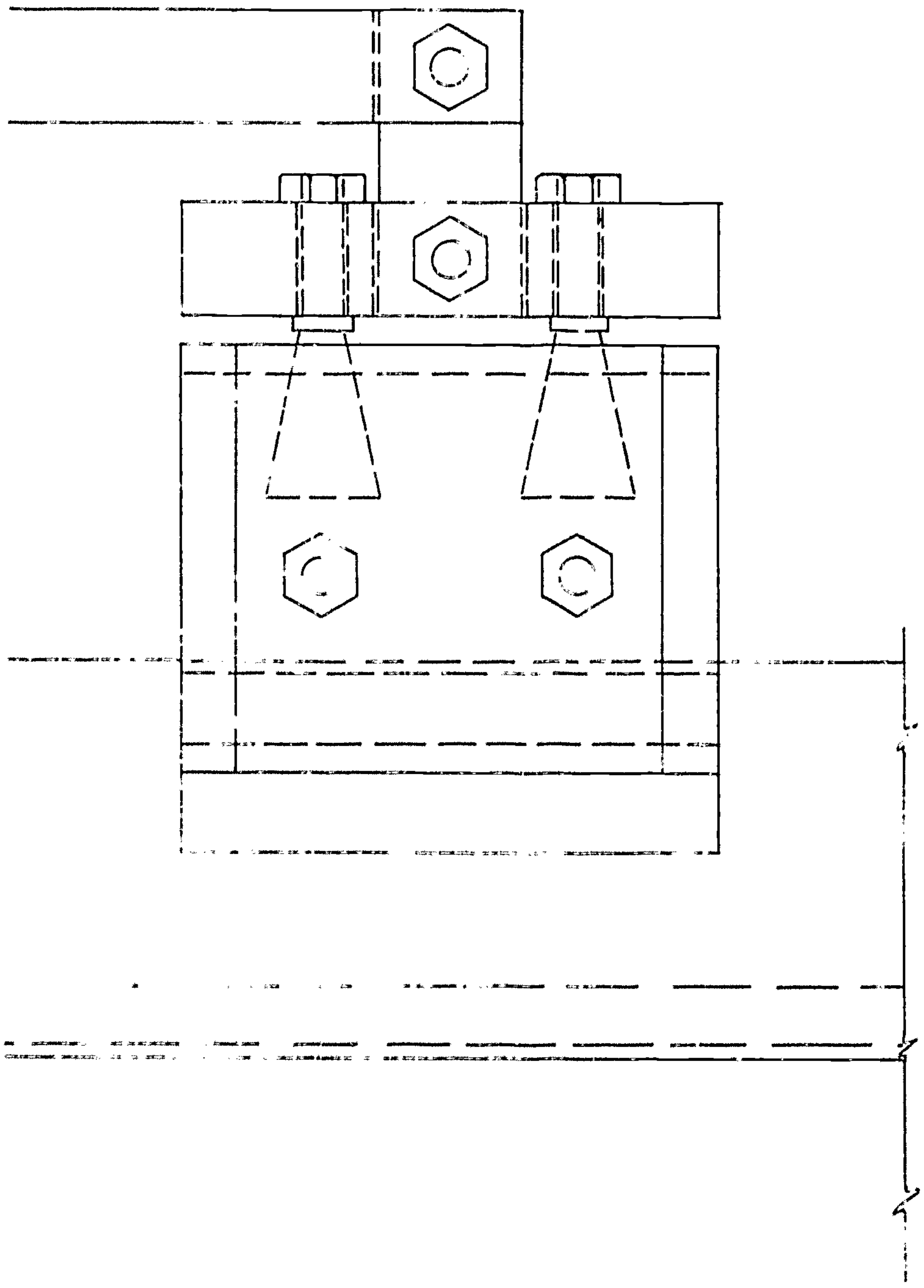
Fig. I-2. A suspended glazing installation

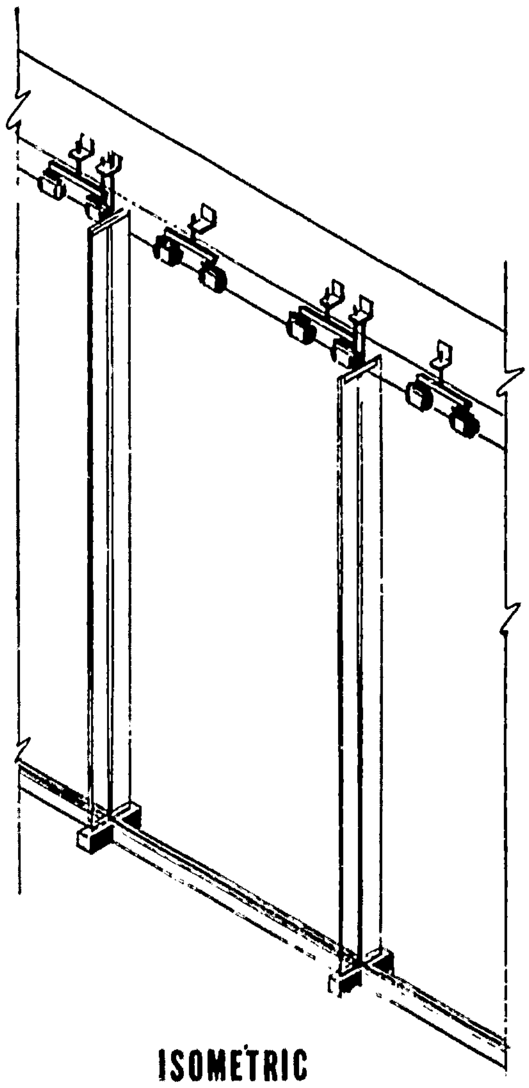

E
ANGLE ATTACHED TO STRUCTURAL SUPPORT
12" MINIMUM WORKING SPACE
1"
11/16"
1"
1 4"
3 3 4"
2 1 2"
STIFFENER
FELT AND SH 10 CEMENT
FACIA PLATE WITH STIFFENERS AS REQUIRED FOR EACH JOB
SEAL AGAINST WEATHER
VARIES
SECTION E-E
CLOSURE TO BE RIGID ENOUGH TO TRANSMIT WIND LOAD FROM GLASS TO STRUCTURE
E
SECTION A-A
TWIN CLAMP

PLAN 11



REFERENCE ELEVATION





ISOMETRIC

SUSPENDED GLAZING

U S PATENT NO 2 907 078

MARK	REV.	BY	DATE

F. H. SPARKS CO., INC. 49 W. 45TH STREET NEW YORK 36, N. Y.

JOB TYPICAL DETAILS AND ELEVATIONS

LOCATION

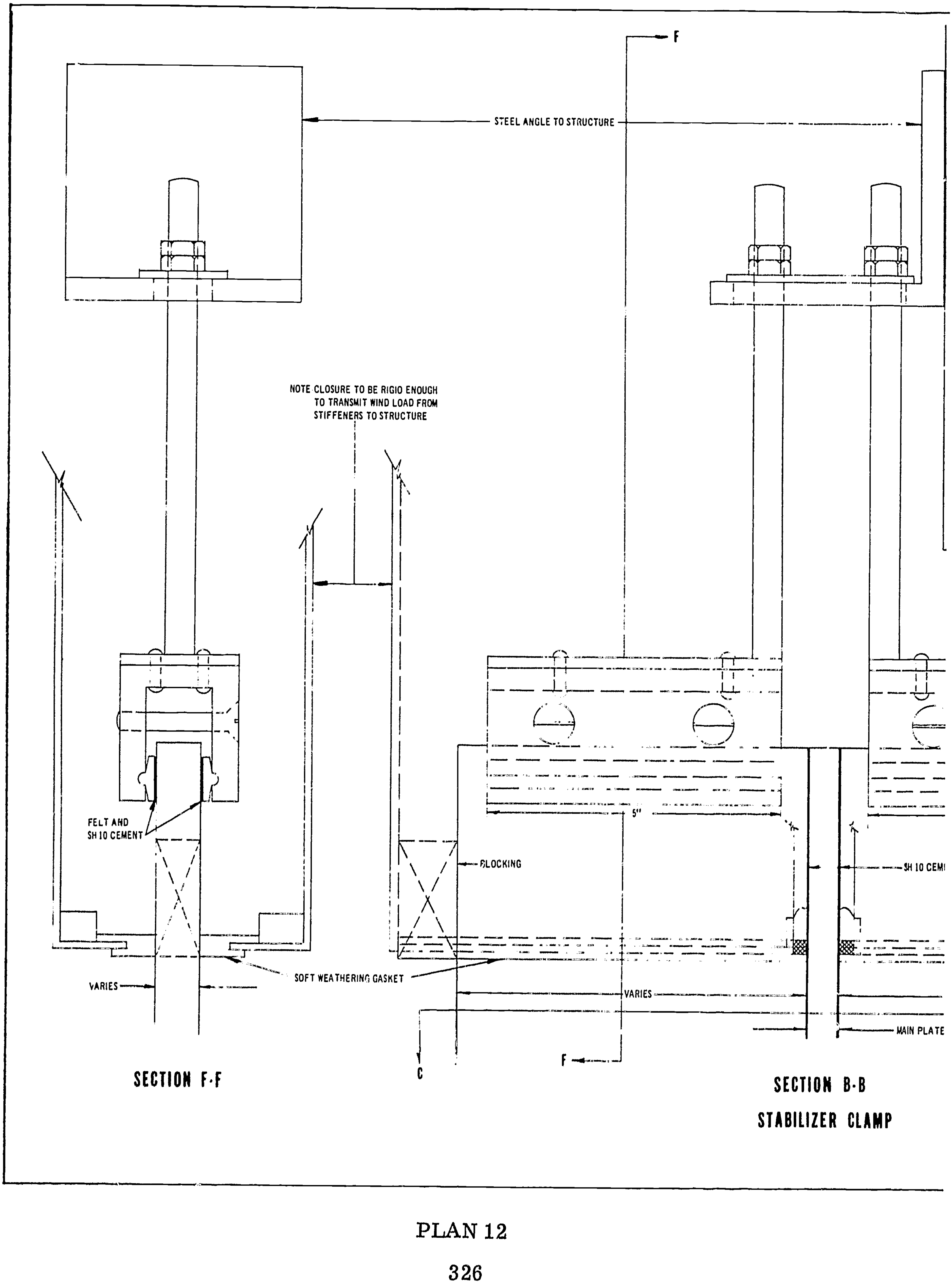
CUSTOMER

ADDRESS

ARCHITECT

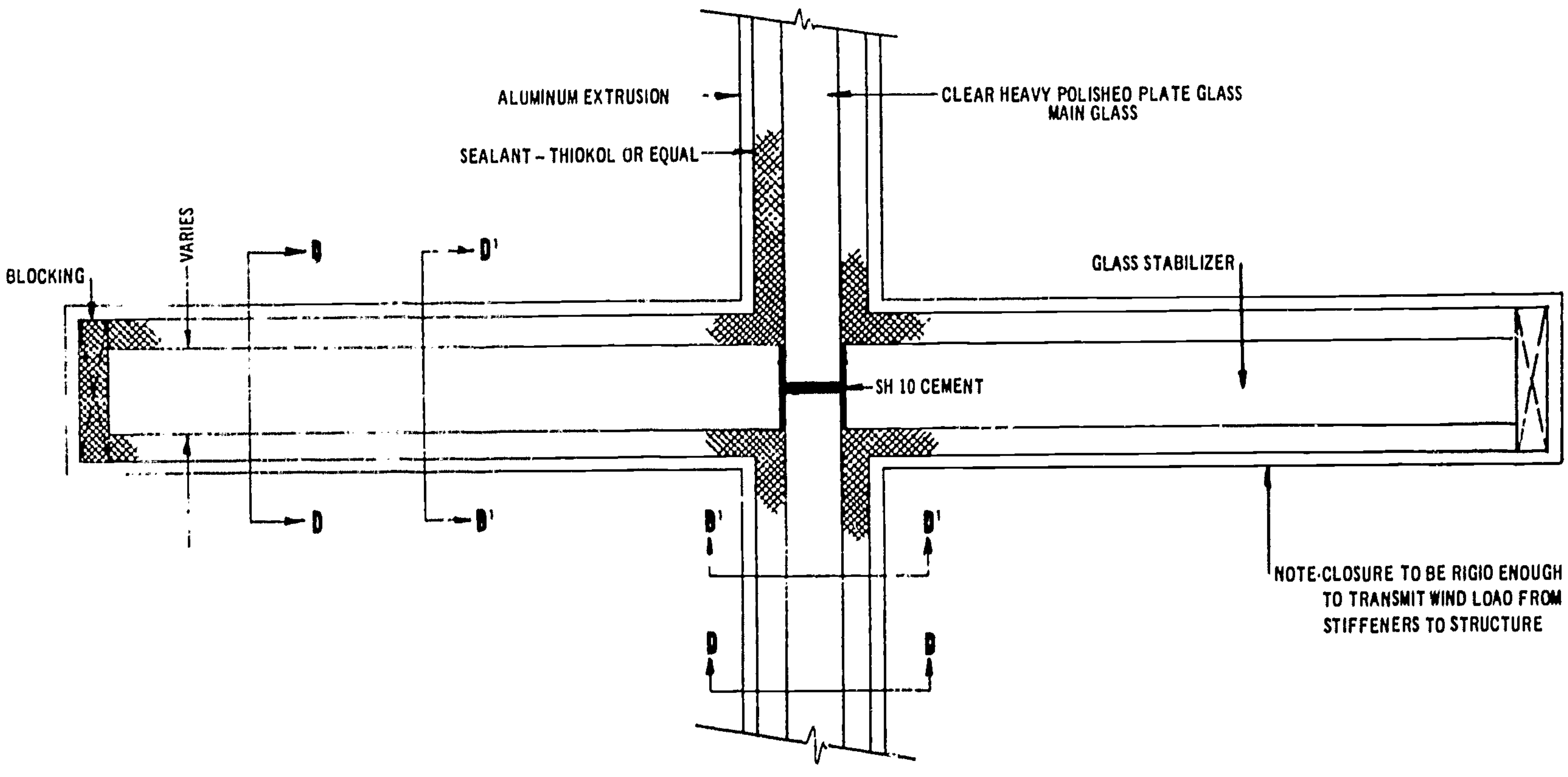
JOB NO SHEET 1 OF 2 DATE 10 11 63

PLAN 11

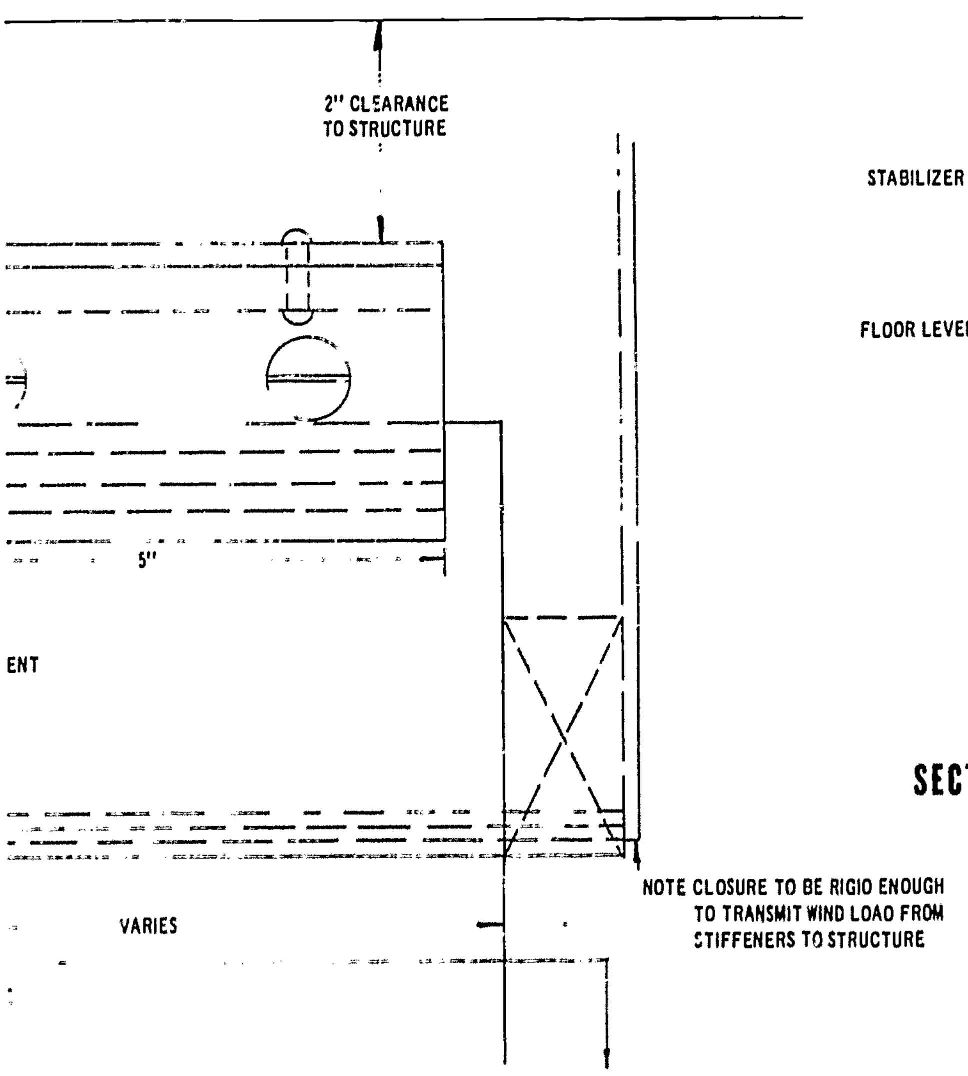


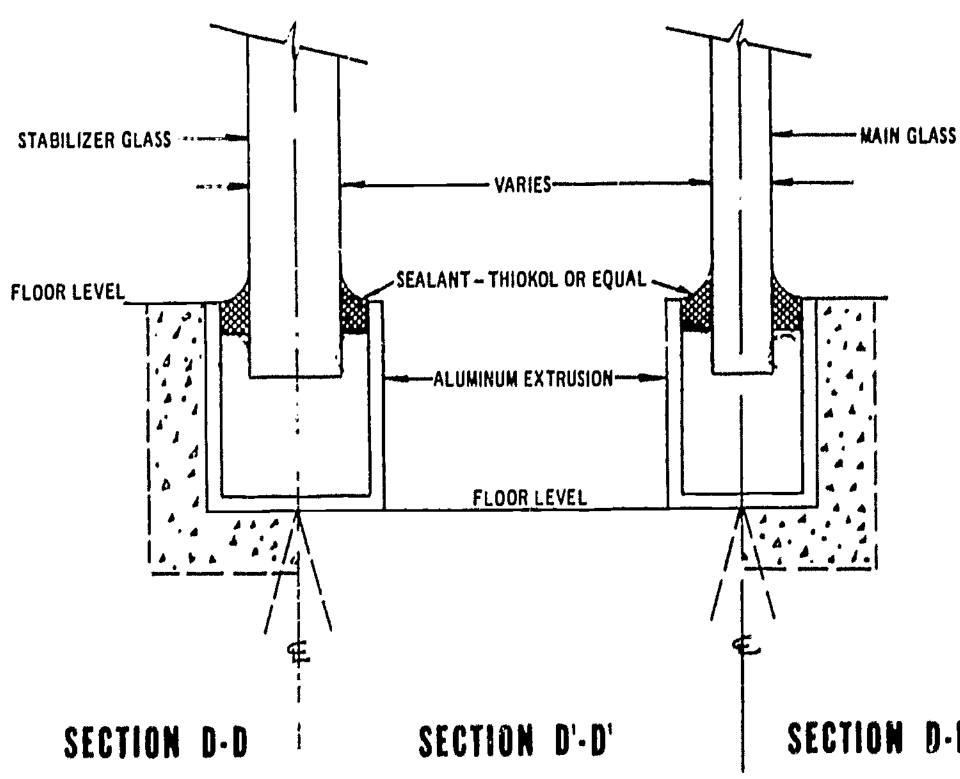
STEEL ANGLE TO STRUCTURE
NOTE CLOSURE TO BE RIGID ENOUGH
TO TRANSMIT WIND LOAD FROM
STIFFENERS TO STRUCTURE
FELT AND
SH 10 CEMENT
BLOCKING
SOFT WEATHERING GASKET
VARIES
5"
SH 10 CEM
MAIN PLATE
F
C
SECTION F-F
SECTION B-B
STABILIZER CLAMP

PLAN 12



SECTION C-C





SECTION D-D SECTION D'-D' SECTION D-D

MARK	REV.	BY	DATE

F. H. SPARKS CO., INC. 49 W. 45TH STREET NEW YORK 36, N. Y.

JOB TYPICAL DETAILS

LOCATION

CUSTOMER

ADDRESS

ARCHITECT

JOB NO. SHEET 2 OF 2 DATE 10-11-63

SUSPENDED GLAZING

U S PATENT NO 2 907 078

PLAN 12

UNIT I--SUSPENDED GLAZING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. In suspended glazing, the __1__ edge of the glass is held in metal __2__, but no __3__ blocks are used.	1. ______ 2. ______ 3. ______
2. The __4__ assemblies employed to suspend the glass may be of either the __5__ or the __6__ type.	4. ______ 5. ______ 6. ______
3. The bronze plates are bonded to the glass with __7__ __8__.	7. ______ 8. ______
4. The glass is sealed into the bottom channel with __9__ __10__, but it is free to move with the __11__.	9. ______ 10. ______ 11. ______
5. If a suspended light breaks, the top piece __12__ in __13__.	12. ______ 13. ______
6. Suspended glazing installations show excellent resistance to __14__ loads.	14. ______
7. Distortion tends to be reduced in suspended glazing because the glass hangs __15__ __16__ in perfect __17__.	15. ______ 16. ______ 17. ______
8. A layer of __18__ is cemented between the glass and the face of the bronze plate.	18. ______
9. The suspension device includes a vertical __19__ rod.	19. ______
10. Suspended glazing was developed in response to the continuing requirement for larger __20__ in construction.	20. ______

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1.	In suspended glazing, the bottom edge of the glass is held in metal channel to keep it from swinging.	1.	T	F
2.	The stabilizers prevent the glass from bowing in the wind.	2.	T	F
3.	The clamps are locked to the glass after it is suspended.	3.	T	F
4.	The stabilizers are set on setting blocks.	4.	T	F
5.	One drawback of suspended glazing is that it limits the height of the glass that can be used.	5.	T	F
6.	A glass stabilizer is put on both sides of the butt joint.	6.	T	F
7.	The glass is held together at the butt joint with an epoxy cement.	7.	T	F
8.	The sill channel helps support the weight of the glass in suspended glazing.	8.	T	F
9.	The glass stabilizers are suspended by means of clamps.	9.	T	F
10.	The glass stabilizers are cemented to the butt joints at a 45° angle.	10.	T	F

UNIT J Special Jobs

TOPIC 1--SPECIAL SURFACE PROCESSES

This topic, "Special Surface Processes," is planned to help you find answers to the following questions:

- What techniques are employed for changing the texture of glass surfaces?
- How are engraving, mitering, and carving employed in the decoration of glass?
- What is the easiest and safest way to etch glass?

Many standard decorative processes are used to increase the beauty and usefulness of flat glass. For example, many of the rollers used for the manufacture of rough rolled glass are patterned. Certain surface processes can also be employed to achieve attractive surface effects on plate or window glass; chief among these are the processes designed to change the texture of the surface, such as sandblasting, etching, grinding, and chipping, and those designed purely for decoration, such as engraving, mitering, and carving. The choice of the process to be used depends, of course, upon the quality of the original surface, the thickness of the glass, and the use to which the product will be put.

Sandblasting, Etching, Grinding, and Chipping

Sandblasted, etched, ground, or chipped glass is most often purchased from manufacturers already processed. However, if these processes are to be applied to glass already on hand, the glazier may need to carry them out.

Sandblasting. The cheapest and easiest method of obtaining a frosted surface on glass is by sandblasting. In this method, a sandblasting gun is used to blow sand, shot, or carborundum against the glass surface. Very fine or very coarse textures can be obtained by varying the pressure on the gun, the size of the abrasive particles used, and the length of time the gun is held in one place. Finely sandblasted glass is sometimes referred to as ground glass, but it should not be confused with mechanically ground glass. Sandblasted glass tends to be fragile and difficult to clean.

Designs can be produced by sandblasting through a stencil that has been sealed to the glass, or by covering the area not to be blasted with a rubber compound. The masked-off area remains clear. Variations in tone or depth of a sandblast design can be secured by successive removal of different portions of a stencil; in this case, the finest-textured sandblasting is left until last.

Carved sandblasting is achieved by holding the gun in one place longer in order to produce a deeper sandblasting job. Plate glass at least 3/8 in. thick is recommended for effective modeling, especially if edge lighting is to be used. Deep modeling requires plate 1/2 in. to 3/4 in. thick.

Decorative effects can be obtained by applying colored paints or lacquers to sandblasted surfaces; this is sometimes referred to as "Italian" processing.

Etching. Acid etching is another method of giving a frosted or semipolished appearance to a clear glass surface. This process depends upon the chemical action of hydrofluoric acid or other fluorine compounds. Hydrofluoric acid (HF) is a colorless, corrosive, volatile liquid which must be handled with great care.

The entire surface of the glass may be etched to give a frosted appearance and to cut down light transmission, or designs may be produced on the glass by etching only selected areas. A stippled effect may be obtained by sprinkling small shot or coarse sand on the glass while it is being etched; this process is called acid stippling. If a design is desired, the portion of the glass to remain clear is first covered with a resinous paint or with paraffin or other wax; then the acid is directed upon the uncovered portion. After the design has been etched into the glass, the acid is flushed away and the "resist" is removed.

Etching may also be done with etching cream, which is easier to obtain than hydrofluoric acid and is much easier and safer to use. Any portions of the glass to be left clear are taped off and the cream is spread like butter over the design. Only two minutes are required for the cream to etch the design well into the glass. The cream is removed from the glass with water.

Etching tends to reduce the strength of the glass. For this reason, etched glass should not be used for partitions or other decorative purposes where the glass could be exposed to stress.

Etching may be used in combination with sandblasting. A pleasing satin finish is obtained from a combination of very light sandblasting and etching. Glass treated in this way is stronger than regular sandblasted or etched glass, but its resistance to impact or stress is less than that of equivalent clear glass. It does not show finger marks and is easily cleaned.

Surface grinding. Mechanically ground glass is used largely for optical and other special purposes. The grinding is done with a roughing machine or other type of grinder, usually with corundum, Alundum, or Aloxite. The smoothness of the resulting surface finish depends to a great extent on the quality of the abrasive used; the finer the grain, the smoother the finish.

Most of the glass referred to as "ground" is in fact either blasted or etched or both, since these processes in general are cheaper and easier than mechanical grinding.

Chipping. An obscure or translucent glass may be given a brilliant surface pattern by the process of chipping. First the glass (usually plate, though not always) is sandblasted lightly to make the surface rough; then the surface is

coated with a special glue called "chipping glue." Next, the glass is either set out in the sun, placed in a room that is at a temperature of 80° F. or higher, or placed in an oven. Exposing the prepared glass to the sun is generally considered to be the most effective method. When the glue dries in the sudden heat, it shrinks and peels off in flakes. As the flakes of glue pop off the surface, they take with them slivers of glass, a process that involves considerable noise.

Light glue tends to take large chips from the surface, heavy glue smaller chips. If still smaller chips and greater obscurity are desired, the process may be repeated; thus, chipped glass is often described as either single-chipped or double-chipped. The shapes of the slivers of glass removed from the surface vary greatly, producing a delicate tracery pattern. Special chipped designs may be obtained by masking the glass prior to the sandblasting and the application of the glue.

Chipped glass was once used extensively in banks and other commercial buildings, but demand has decreased in recent years. However, the process is still used occasionally. One of the chief disadvantages of chipped glass is that it catches dirt easily and is difficult to clean.

Engraving, Mitering, and Carving

Engraving is done on the glass surface with motor-driven grinding wheels or sometimes with special copper engraving wheels. The wheel revolves at a rather low speed while the workman holds the glass pressed against or directly below it. The edges of engraving wheels range in shape from a V to a flat surface. If the edge is V-shaped, the wheel is called a mitering wheel, and the engraved line may be referred to as a miter. Mitering, which is usually done in a straight line, is most often used on plate glass door panels or mirrored surfaces. After engraving or mitering has been done, the groove is usually sandblasted or polished. Carving is done by deep wheel grinding and then polishing. This method of decoration is especially effective when used on edge-lighted decorative panels.

UNIT J--SPECIAL JOBS

TOPIC 1--SPECIAL SURFACE PROCESSES - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. Some special surface processes change the __1__ of the surface; others are purely __2__ processes.	1. ________ 2. ________
2. Sandblasted glass tends to be __3__ and difficult to __4__.	3. ________ 4. ________
3. When several textures are to be produced on a single piece of glass by sandblasting, the __5__ sandblasting is done last.	5. ________
4. The decorative process that involves the application of colored paints or lacquers to sandblasted glass surfaces is sometimes called __6__ __7__.	6. ________ 7. ________
5. Mechanically ground glass is used largely for __8__ or other __9__ purposes.	8. ________ 9. ________
6. Before a glass surface is chipped, it should be __10__.	10. ________
7. Chipping is best done by exposing the prepared glass to the __11__.	11. ________
8. Glass can be etched with __12__ acid, but an easier and safer method is to use __13__ __14__.	12. ________ 13. ________ 14. ________
9. The smoothness obtained on a mechanically ground glass surface depends to a great extent upon the quality of the __15__ used.	15. ________
10. Masking for sandblasting is done with a __16__ or a __17__ compound.	16. ________ 17. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. When specifications call for etched glass, the usual procedure is for the glazier to order plate glass and etch it in the shop.	1.	T	F
2. Sandblasting is the cheapest method of obtaining a frosted surface on glass	2.	T	F
3. Chipping is usually performed on heavy sheet glass.	3.	T	F
4. Acid stippling is done with carborundum or very fine sand.	4.	T	F
5. A copper wheel is sometimes used for engraving.	5.	T	F
6. Hydrochloric acid is used for etching glass.	6.	T	F
7. A double-chipped plate has a fine chipping pattern.	7.	T	F
8. Engraving wheels turn at high speed.	8.	T	F
9. Mitering is a type of decoration frequently employed on mirrors.	9.	T	F
10. Most so-called ground glass is in fact sandblasted or etched glass.	10.	T	F

UNIT J--SPECIAL JOBS

TOPIC 2--AQUARIUMS

This topic, "Aquariums," is planned to help you find answers to the following questions:

- What considerations are of greatest importance in the glazing of an aquarium?
- What metal is preferred for the aquarium frame?
- What procedure should be followed in the assembly and testing of an aquarium?

Building an aquarium is a highly specialized job that cannot be accomplished without a certain amount of special knowledge. Regardless of the size or shape of an aquarium, the two most important considerations in the work are the thickness of the glass and the quality of the cement to be used. The glass must be sufficiently thick to withstand the pressure of the water, and the structure must not leak. The glazier will not generally determine the thickness of the glass for the job, since this requires a knowledge of hydraulic engineering. However, given the correct glass with which to work, he is responsible for seeing that the finished aquarium does not leak.

Framework

Although the expected water pressure on the glass is compensated for by the thickness of the glass used, an aquarium cannot be expected to support the water pressure at the joints merely by means of the cement between lights; the glass must be installed in a frame of some type, metal being almost universally employed for this purpose. The larger the aquarium, the stronger and stiffer the metal frame needs to be.

Many metals are currently in use for the frames of home aquariums, ranging from painted angle iron to solid copper or brass; iron, either painted or galvanized, is usually the least expensive frame metal. It can be very attractive when it is properly maintained. Because of the metal's tendency to oxidize and to combine with the water to form minerals that may kill the fish, an iron frame must be painted, preferably with black asphaltum. The paint should be retouched whenever it gets scratched.

Aluminum is somewhat more expensive than iron, but it makes an aquarium frame that is light, strong, rust-resistant, and attractive. Probably the best combination of appearance and easy maintenance, however, is offered by stainless steel, which is more expensive than aluminum in some places but can be bought very cheaply as surplus in others. Unlike iron, aluminum, copper, and brass, which can be dangerous to fish, stainless steel is almost entirely resistant to corrosion in fresh water. It takes a high polish and can be kept

shining with a variety of metal cleaners (none of which, however, must ever be spilled into the tank itself).

Cement

No aquarium should be assembled without the correct cement. A special aquarium cement is made for this purpose, with certain properties that make special handling necessary. This is the only type of cement that should be used, because it is nontoxic; regular showcase cement would kill the fish. Under no circumstances should the cement be touched with the hands. The small amount of oil present on the skin will destroy the adhesive qualities of the cement in the contaminated area. Aquarium cement should be warmed in hot water before it is used; this will loosen the cement in the container and make it more pliable.

Installation Procedure

When the glass is cut for the frame, sufficient clearance should be allowed for the cement between frame and glass, but in order to ensure leakproof joints, this clearance should be kept to a minimum; in most cases, it should not exceed 1/8 in. For smaller sizes (such as three-gallon tanks), 1/16 in. clearance is ample. After the glass has been cut to size, the edges to be cemented should be cleaned thoroughly to ensure that no oil or grease is present. Next, the metal channels of the frame should be cleaned with a solvent that does not leave a greasy residue.

The glazier should proceed as follows in assembling an aquarium:

1. Bed the bottom channel of the frame with cement, using a putty knife or other similar tool. Do not touch the metal or the cement with bare hands.

2. Put the bottom light of glass in place. Use a firm and even pressure to force the cement out of the frame, thus squeezing out all air trapped between the glass and the cement.

3. Follow this same procedure for the sides of the aquarium. (Some glaziers prefer to install the sides first and place the bottom last.)

4. Smooth out any excess cement on the inside to help make a watertight seal. Trim away all excess cement on the outside.

5. Fill the aquarium with warm water. The pressure and warmth of the water will force the glass into place. Check for leaks. If small leaks occur, it may be possible to seal them by forcing fresh cement between the channel and the glass. If this does not stop the leak, it will probably be necessary to tear down the work and start over.

Most leaks in newly assembled aquariums are caused by dirty channel or glass or by cement that has been handled and will therefore not bond properly. For all aquariums, large or small, proper sealing of the edges is of primary importance. No job can be considered finished if there is any tendency for any joint to leak.

UNIT J--SPECIAL JOBS

TOPIC 2--AQUARIUMS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The two most important considerations in aquarium glazing are the __1__ of the glass and the quality of the __2__.	1. ______ 2. ______
2. An iron frame should be painted, preferably with __3__ __4__, for the protection of both the __5__ and the __6__.	3. ______ 4. ______ 5. ______ 6. ______
3. The least expensive metal for an aquarium frame is usually __7__.	7. ______
4. One desirable quality of stainless steel as a material for aquarium frames is its resistance to __8__.	8. ______
5. Aquarium cement should be __9__ before it is used.	9. ______
6. The metal channels of the frame should be thoroughly cleaned with a __10__ that leaves no __11__ residue before assembly of the aquarium is begun.	10. ______ 11. ______
7. The cement should be bedded in the frame channels with a __12__ __13__ or similar tool.	12. ______ 13. ______
8. Excess cement should be __14__ __15__ on the inside and __16__ __17__ on the outside.	14. ______ 15. ______ 16. ______ 17. ______
9. Small leaks in the assembled aquarium can sometimes be sealed by forcing __18__ __19__ between the channel and the glass.	18. ______ 19. ______

10. The determination of glass __20__ required for a given aquarium glazing job is not usually the responsibility of the glazier. 20. __________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. If no special aquarium cement is available, showcase cement will be satisfactory for sealing the aquarium joints.	1.	T	F
2. The best metal for an aquarium frame, from all points of view, is iron.	2.	T	F
3. The special enemy of aquarium cement is oil.	3.	T	F
4. Aquarium cement should never be forced into place with the bare hands.	4.	T	F
5. The glass should be pressed into place on the cement bedding until the cement squeezes out.	5.	T	F
6. The clearance for cement between the glass and the aquarium frame should not exceed 1/16 in. for any aquarium.	6.	T	F
7. Checks for leaks in a newly assembled aquarium should be made with warm water.	7.	T	F
8. The glazier is responsible for seeing that the aquarium joints do not leak under the pressure of the water.	8.	T	F
9. Metal cleaners can be used safely on an aquarium frame with no special precautions.	9.	T	F
10. Most leaks in aquariums are caused by the use of insufficient cement.	10.	T	F

UNIT J--SPECIAL JOBS

TOPIC 3--AUTO GLAZING

This topic, "Auto Glazing," is planned to help you find answers to the following questions:

- What are the National Auto Glass Specifications?
- What lights of auto glass must be obtained from stock, and what lights can be cut in the shop?
- How are the various lights of auto glass installed?

The installation of glass in automobiles provides a good opportunity for those who prefer inside work. Although the work is routine in many ways, it offers a constant challenge because of the many different types and models of cars involved. In most localities, very few glaziers move back and forth between the flat glass shops and the auto glass shops, but the man who can work in both has a tremendous advantage, especially to employers with shops in both fields.

Types of Auto Glass

Auto glass is manufactured in America by two large glass companies and one automobile company (Ford). Curved windshields and backlights are purchased already fabricated, but sidelights, unless of tempered glass, are cut to a pattern by the glazier. In older car models, the windshields and sidelights were made of safety glass, the backlight of tempered glass. In many recent models, all the lights except the windshield are made of tempered glass.

National Auto Glass Specifications

National Auto Glass Specifications are published for each model of each make of car, with a number assigned to each piece of glass. When a particular job is to be done, the auto glazier checks the parts book containing the specifications and finds the number of piece to be replaced. If the piece is curved, or if it is tempered glass, he must get it from stock. Otherwise, he should have in his files a pattern corresponding to that number; this is used to cut the piece from a stock size of safety glass. The NAGS number is used to identify the particular piece of glass wherever it is mentioned.

Principles of Installation

Three fundamental types or principles of installation have been developed over the years by the three major automobile manufacturers: Chrysler, General Motors, and Ford. The minor producers have each followed one of these principles. However, in recent years, the three have become increasingly similar. Almost all installations are now made from the outside, except for doorlights and quarter glass. The installation parts of all three are basically

similar and are described by the same general terms, although their exact shapes may differ somewhat. The tools used are generally the same, although a few are specialized for one or the other type of installation.

Study Assignment

Study the following:

1. Auto glass installation tools illustrated in any standard glazing tool catalog (that of Sommer and Maca, for example)

2. The parts and the methods of installation described in the auto glazing manuals published by the Pittsburgh Plate Glass Company and the Libbey-Owens-Ford Glass Company

3. The pattern system described in parts books containing National Auto Glass Specifications

UNIT J--SPECIAL JOBS

TOPIC 3--AUTO GLAZING - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the following exercises:

1. Describe and identify the function of each of the following basic installation parts:

   Garnish molding
   Reveal molding
   Pillar drip molding
   Checking blocks
   Pinchweld flange

2. Name and describe as many as you can of the various types of windshield weatherstripping.
3. Name and describe the various types of compounds and sealers used in auto glass installation.
4. Explain why a windshield should be seamed before it is installed.
5. Describe as many as you can of the tools needed for a doorlight installation.

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. Most flat glass shops also provide auto glazing service on the premises.	1.	T	F
2. Curved windshields are purchased by the shop as prefabricated units.	2.	T	F
3. Automobile sidelights of safety glass are cut to a numbered pattern by the glazier.	3.	T	F
4. All American glass manufacturers make auto glass.	4.	T	F
5. Each piece of glass used in each make and model of car is identified by means of an NAGS number.	5.	T	F
6. In many recent cars, all lights except the back-light are made of tempered glass.	6.	T	F
7. Edgework may be required on tempered glass side-lights obtained from stock.	7.	T	F
8. Three fundamental types or principles of auto-glass installation are in current use.	8.	T	F
9. Standard flat-glass glazing tools will suffice for all auto glazing procedures.	9.	T	F
10. Curved auto glass must be obtained from stock.	10.	T	F

UNIT J--SPECIAL JOBS

TOPIC 4--ART GLASS

This topic, "Art Glass," is planned to help you find answers to the following questions:

- What is art glass?
- How is an art glass window designed?
- What are the steps in the construction and installation of a stained glass window?

The Origin of Art Glass

Relatively simple, undecorated stained glass windows were employed in churches as early as the fourth century A. D., but the art glass or pictorial stained glass window was a much later development, probably originating in the eleventh century. By the middle of the twelfth century, the art of applying line work designs to stained glass was flourishing, and several examples of the elaborate and beautiful art glass windows of this period can still be seen in old cathedrals in England and Europe. The art of stained glass reached its high point in the fourteenth century and fell into decline in the seventeenth century; however, a revival of interest in art glass is well under way today, and contemporary glass artisans are producing windows of great beauty not only for churches but for many other types of buildings as well.

Design and Construction of Stained Glass Windows

The unique feature of a stained glass window is that light is passed through it to display the color, not reflected from it as in a conventional painting. Because of this, the colors are fresh and cheerful, depending for their brilliance upon the sunlight; and the window presents a multitude of subtly different pictures with the changing lights of days and seasons. The artisan designs his window to take fullest advantage of these qualities of art glass.

The design and construction of a stained glass window or panel involves the following operations:

1. Designing. The design is first worked out on paper at a convenient size and in proportion, to be scaled up later to the full size of the proposed window. The small drawing shows not only the picture design but the general color scheme as well.

2. Making the cartoon. The approved design is next enlarged to full size. The enlargement--called a "cartoon"-- is usually made by drawing; in this case, care must be taken to see that the cartoon preserves the proportions and artistic quality of the small sketch. For speed and accuracy,

the small sketch can be enlarged to full size by photography, though this is not usually possible in the small workshop.

3. Cutting. A piece of tracing cloth or paper is spread over the cartoon, and lines are drawn showing the size and shape of each individual piece of glass required to form the whole window. These lines are spaced to allow for the thickness of lead between the various pieces of glass. The tracing (called the "cutline") is marked to show the color of the glass required for each piece, and all the pieces are then cut to size.

4. Waxing up. When all the pieces are cut, they are temporarily secured in their correct positions on a large sheet of clear glass with drops of molten beeswax at the corners. An even margin, representing the core of the lead, must separate all the pieces of glass. Once the pieces have been waxed in place, the glass sheet may be fitted to an easel or frame and held up to the light to show the effect of the colors and to permit visualization of the general layout of the window.

5. Etching. If the window incorporates flashed glass--base glass coated with a thin layer of glass of another color--the top layer of the glass is etched away in accordance with the design to reveal the base glass.

6. Painting. The painting of line work now takes place. The lines may be drawn directly onto the window as a whole where it stands on the easel, or they may be drawn on the separate pieces removed from the frame and placed on the cartoon. The last method enables the worker to trace the lines of the cartoon with great accuracy.

7. Firing. When the desired amount of pigment is added to the glass, the separate pieces are placed in a kiln and fired to about 850° C. The firing operation fuses the pigment with the glass surface and makes the coloring permanent.

8. Further waxing up and painting. After the first firing, the glass is again waxed up into position and further painting is done. The second painting is usually concerned with matting, stippling, and other brush work which supplements the already fired line work. Should the first or second firing be in any way unsuccessful, the glass may be touched up where necessary and given an additional firing.

9. Staining. Silver stain, if required, should now be applied; this material is generally painted on the back of the glass and fired at a temperature somewhat lower than that required for opaque pigments. The result is a color varying from pale lemon to deep orange.

10. Leading up. The separate pieces of finished glass are next placed on a flat bench or board and are joined together by strips of lead called "calm." Seen in section, the lead strip looks like the letter "H," the top and bottom of the H forming the pockets for the glass.

11. Soldering. The lead joints are now cleaned and soldered. When all the joints on the front face of the window have been soldered, the window is carefully turned over and soldered on the reverse side.

12. Cementing. A cement of suitable type is next brushed into the spaces between the lead and the glass. The leads are then pressed down neatly and cleaned, and the window is left for the cement to dry.

13. Fitting. The finished work may be fitted to a window space; if so, it may require strengthening in some way. Alternatively, the stained glass work may be in the form of a panel to be hung before a strong light; in this case, it may be unframed or lightly framed in wood, or wire may be threaded around the outside leads and a loop made at the top for hanging.

UNIT J--SPECIAL JOBS

TOPIC 4--ART GLASS - STUDY GUIDE AND TEST

Study Guide

After you have studied the material in the workbook and the assigned material, complete the exercises as follows: (1) determine the word that belongs in each numbered space in an exercise; and (2) write that word at the right in the space that has the same number as the space in the exercise.

1. The use of art glass for church windows probably originated in the __1__ century A. D. — 1. ________
2. The unique feature of a stained glass window is that the colors are brought to life by __2__ passing through the __3__. — 2. ________ 3. ________
3. In the making of the cartoon, the proportions and artistic quality of the __4__ __5__ must be preserved. — 4. ________ 5. ________
4. The pieces of glass are cut in accordance with a tracing called the __6__. — 6. ________
5. When all the glass pieces for the window have been cut, they are secured temporarily in their correct positions on a large __7__ of clear __8__ with beeswax. — 7. ________ 8. ________
6. The waxing-up process permits the artisan to study the effect of the __9__ and to visualize the general layout of the __10__. — 9. ________ 10. ________
7. After the line work has been painted on the glass, the pieces are __11__ in a __12__ at a temperature of about __13__. — 11. ________ 12. ________ 13. ________
8. The process of joining the glass pieces to form the completed window is called __14__ up. — 14. ________
9. The lead strips employed in a stained glass window are shaped in section like the letter __15__. — 15. ________
10. If the completed window is to be fitted into a window space, it may require __16__. — 16. ________

Test

Read each statement and decide whether it is true or false. Circle T if the statement is true; circle F if the statement is false.

1. The design sketch for a stained glass window is called a cartoon.	1.	T	F
2. Photography is used to make the cutline.	2.	T	F
3. The cutline is marked to show the color of the glass required for each piece in the window.	3.	T	F
4. In waxing up, it is important to have an even margin between pieces.	4.	T	F
5. Etching flashed glass reveals the base glass.	5.	T	F
6. Painting of the glass pieces can be done on an easel.	6.	T	F
7. The firing operation fuses the lead to the glass.	7.	T	F
8. Silver stain is sometimes applied and fired on the back of the glass to give it a color ranging from pale yellow to deep orange.	8.	T	F
9. The strips of lead that join the pieces of glass are called "seams."	9.	T	F
10. The lead joints are cleaned before they are soldered.	10.	T	F

Glossary

The definitions of terms included in this glossary are those that are pertinent to the glazing trade and are not necessarily those found in standard dictionaries. Some of the terms included are colloquial in nature and are used with the meanings given for the glazing trade only.

Abrasion--The rubbing away of material, as in grinding glass.

Alcove--Any large recessed portion of a room.

Annealing--Heating glass in order to fix laid-on colors, to soften it and make it less brittle, and to remove stains resulting from previous heat treating.

Anodized aluminum--Aluminum with a finish that is produced by an electrochemical process to give the metal a hard, glass-like finish that is easy to maintain. The anodized aluminum surface is approximately twenty times harder than that of untreated aluminum and is corrosion resistant.

Aquarium--A glass container of almost any size used for display of aquatic life.

Arch--A structure spanning an opening, usually in the form of a curve.

Ashlar, or ashler--A facing of square or rectangular pieces of material, such as thin slabs of structural glass, used to cover a wall. Structural glass ashlars are usually 8 in. x 16 in.

Astragal--A small convex moulding or bead.

Autoclave--A container used mainly to apply heat and pressure simultaneously. Used to make laminated glass.

Awning windows--A window with a frame of wood, steel, or aluminum pivoted at the top and opening out at the bottom.

Barricade--A screen of boards or plywood used to enclose a construction area. Protects the public from construction hazards and accidents.

Baseboard--The lowest wood trim on a wall next to the floor, sometimes called a mopboard.

Bay window--A windowed recessed area in a room projecting beyond the wall line and commencing at the floor line. The window itself is called a bay.

Bead--A strip of moulding.

Beam--A horizontal support of wood, steel, or other material used to carry a load over a large opening from post to post.

Bearing wall--A wall or partition that supports the floor or weight above.

Blemish--A defect or flaw in glass or aluminum.

Bracket--A support projecting from a wall, usually intended to carry ornaments; made of various types of materials.

Brake moulding--The forming of simple angular shapes by placing flat sheet aluminum in a hand or power brake.

Brown coat--The second coat of plaster applied.

Bulkhead--An upright partition wall or structure. On a store front, the wall or structure between the sill and the sidewalk or floor.

Bullet hole--A small hole in a light of glass resulting from the light being struck by a small object--a stone, buckshot, or the like--at high speed.

Butt joint--Joint formed at the point at which two pieces of material butt together.

Canopy--The suspended covering over an entryway or doorway.

Casement window--A window that opens on hinges affixed to the vertical edge of the window frame.

Ceramic tile--Clay that has been baked with a glazed surface in pieces of various shapes. Used for floors or walls of bathrooms and for decorative facing of exterior walls or pilasters.

Chair rail--A moulding, usually of wood, that goes around the room at the height of a chair back.

Chamfer (champfer)--A furred, beveled edge.

Clerestory (clearstory)--The portion of a building or multistory room that rises above other parts of the structure, or above the height of a single story, and that contains windows for light or ventilation.

Cold rolling--A method of forming metal into various shapes by passing it through a series of roll dies. Also, forming a square ribbon of metal into a thin, detailed sash or moulding.

Column--A vertical shaft; a prop or a support. Also, any object resembling a column in form and position.

Concave--Curved inward.

Conduction--Transmission of a substance or of energy in some form, as for example water through pipe; current through wire; heat through metal; or heat through the walls and roof of a building.

Convex--Curved outward.

Cornice--A projection at the top of a wall.

Corrosion--The destruction or eating away of a substance by a chemical process.

Course--A continuous layer of glass blocks or structural glass in a building.

Crown glass--Any glass containing the usual soda, lime, and silica but modified by additional materials to make optical glass.

Cullet--Cutoffs and broken glass, also used in the manufacturing of new glass.

Curtain wall--A nonbearing wall of nonstructural materials attached to structural members such as steel or cement columns or piers.

Decal--A printed or painted picture on a process paper that can be dampened and transferred by gumming to a surface of glass.

Detention windows--Fixed steel windows having small window lights approximately 6 in. x 9 in. with vents to open outside of the fixed steel muntins; used mainly in institutions.

Dormer--A vertical window in a small gable rising from a sloping roof.

Double-acting door--A hinged door that will open in both directions.

Double doors--A pair of doors hinged at the sides and coming together in the center, or a pair of doors hinged in the center and closing at the jamb or side of the door frame.

Double glazing--Two separate panes of glass, in one frame or two, separated by an air space of dry air, and sealed permanently around the perimeter of the unit.

Double-hung windows--Two sliding window frames hung in such a way that they may slide up and down past each other.

Eaves--The margin of the roof hanging over the side wall.

Elevation--A geometrical drawing of the exterior upright parts or walls of a building or structure.

Erection--The raising of a building or part of a building, as in the erection of a curtain wall.

Escutcheon--A shield or ornamented plate used to protect the door from the wear of the key.

Extrusion--The forcing of metal at high pressure and temperature through a die to form it into the desired shape.

Fabricate--To frame, construct, or build; to process glass in certain ways, particularly to notch or cut holes.

Face--The whole exterior front of a building or structure that can be seen at one view.

Firewall--A vertical structural barrier or wall built to resist fire and to prevent its spread.

Flaking--In cutting glass, small chips leaving the sides of the cut when the wheel is pressed too strongly or when a sharp cutter is used incorrectly.

Flashing--A piece or pieces of metal inserted at any point on a building at which leakage of water might occur; usually employed around dormers and chimneys and at angles.

Flint glass--Optical glass containing lead.

Floor plan--An architectural drawing of a horizontal section of a building. It shows the exterior walls; partitions; sizes, shapes, and arrangement of rooms, corridors, and so forth; and location of windows, doors, and fixtures.

Furring--A flat piece of wood, steel, or aluminum used to correct an irregular surface by making it even, plumb, or level.

Gable window--A large window under a gable, most often the window in the gable itself.

Girder--A large timber, concrete, or steel beam used to support joists or walls.

Glass--An amorphous (uncrystallized) substance, usually transparent, most often produced by fusing silica sand, soda, and lime, but often including other materials, such as borates and phosphates.

Glazing--The setting of glass in window frames, door panels, and other openings.

Greenhouse--A building constructed mainly of glass for the protection and growing of tender plants.

Grille--A grating of screen, metal, or other material used in the protection of windows or other openings.

Ground--A piece of wood embedded into plaster or cement to which other materials such as sash can be attached.

Grout--A mortar or cement thinned sufficiently to fill joints or cracks around masonry work.

Gutter--A wooden or metal channel at the eaves or on the roof for carrying off rainwater.

Incurve--A bending or curving inward; also an incurve cut; that is, a cut into the edge of a piece of glass.

Jamb--The side post or lining of a doorway or window.

Joist--A horizontal timber to which the boards of the floor or the laths of the ceiling are nailed.

Kalamein door--A wooden door covered with a light gage metal; used as a fire-retardant door when made according to specifications of the National Fire Underwriters.

Kick plate--A plate sometimes fitted to the bottom of a door to protect the door against damage from impact of toes or heels; usually found on swinging doors.

Light--A term applied to any one of the different pieces of glass in a window; loosely, any piece of transparent or translucent flat glass intended for glazing purposes.

Litharge--Fused lead monoxide ground to a fine powder; added to wood putty for speeding up the hardening process.

Louver--A type of window with sloping slats that keep out the rain and provide ventilation.

Mantel--A shelf installed over a fireplace in front of the chimney, usually for ornamental purposes.

Marquee--A projection such as an awning or permanent hood over the entrance of a building.

Mastic--A thick adhesive, usually a mixture of bituminous preparations.

Mezzanine--The intermediate story or balcony overlooking the main floor, between the main floor and the floor above.

Miter--The edges of two pieces of material joining at an angle. Each edge is cut at one-half of the angle of the joint. The joint itself is also sometimes called a miter.

Mullion--The vertical division between several windows.

Muntin--The horizontal bar dividing window lights.

Parapet--The low wall along the edge of a roof, bridge, or terrace.

Perspective drawing--A geometrical representation of an object upon a plane surface so that it will appear as it would in three-dimensional form to an observer's eye.

Pilasters--Vertical shafts attached to and projecting from a wall.

Pillar--A vertical, upright support.

Plate Glass--Ground and polished glass, as distinct from window or sheet glass.

Plumb--In the exact vertical direction; that is, perpendicular. ("Off plumb" would mean not vertical or true.)

Pot-colored--A term used to describe solid-colored glass.

Projected windows--Windows with wood, steel, or aluminum frames that pivot horizontally at the top or bottom to permit opening to the outside or inside. Such windows have balance arms and sliding shoes on both sides of the sash.

Protection or security windows--Steel windows for commercial buildings having larger glass openings than those found on detention-type windows; glass size is approximately 6 in. x 18 in.

Pumice--A hardened volcanic-glass froth used for smoothing and polishing glass.

Push bar--A bar or handle on a door at hand height.

Push plate--A plate on a door at hand height; protects the door against damage at the point where it receives hard use.

Return--The continuation of a projection, moulding, or wall in another or opposite direction.

Reveal--The vertical (or horizontal) side of an opening between the face or front of the wall and the window, door frame, or other object in the opening.

Sash--The framework that holds the glass in a window.

Scale drawings--Drawings whose measurements are relative to and proportional to the actual object drawn, such as a drawing of a building on which 1/4 in. equals 1 ft.

Section drawing--A drawing showing the internal construction and dimensions of the various parts of a structure. A section drawing shows interior structural arrangements that cannot be shown in floor plans and elevations.

Seed--A small bubble (of less than 1/32 in. diameter) in glass.

Shop drawing--A drawing made up for the purpose of fabricating a particular object or objects; a working drawing.

Short finish--A piece of glass whose surface has not been completely polished.

Sill--Most frequently, the horizontal framing member at the bottom of a door or window.

Single-acting door--A hinged door that is restricted to opening only one way.

Skylight--A window in the roof or ceiling to admit light.

Soffit--The underside of an archway, cornice, or other similar minor part of a building.

Spall--A chip on the edge of a piece of glass.

Spandrel--The space between the head of one window and the sill of a window above it.

Specifications--The printed information about a set of plans that designates the kind, quality, and quantity of work and materials to go into a building.

Stile--The upright framing pieces into which secondary members are fitted.

Storm windows or sash--Extra outside removable windows or sash applied to the permanent windows to add weather protection.

Structural glass--An opaque glass used in facing walls and floors.

Templet (template)--A pattern, usually of wood or metal, used as a guide in cutting a desired shape or mounting a component.

Terrazzo--A floor made up of cement and crushed marble chips of various colors, rolled and rubbed smooth and even.

Threshold--The pieces of material fitting under the door.

Transom--A small window over a door or over another window.

Window--An opening in a wall or door for the admission of light, air, or both, usually incorporating fixed or operable glazed sash.

Instructional Materials

INSTRUCTIONAL MATERIALS REQUIRED

Architectural Data Handbook (Fifth edition). Pittsburgh: Pittsburgh Plate Glass Company, 1965.

Construction Safety Orders. Sacramento: California State Department of Industrial Relations, Division of Industrial Safety, 1965. (Sold by State of California Documents Section, P.O. Box 1612, Sacramento, California 95807.)

Course in Glazing (Workbook and Testbook). Sacramento: California State Department of Education, 1967.

Dalzell, J. Ralph and Others. Building Trades Blueprint Reading: Part 1--Fundamentals. Chicago: American Technical Society, 1956.

Glazing Manual. Topeka: Flat Glass Jobbers Association, 1965.

Hobbs, Glenn M., James McKinney, and J. Ralph Dalzell. Practical Mathematics. Chicago: American Technical Society, 1940. (The separate sections of this book can be ordered from the publisher in optional pamphlet form. Sections 1, 3, 4, 5, 6, and 12 are required for the course in glazing.)

INSTRUCTIONAL MATERIALS RECOMMENDED

Electrical Safety Orders. Sacramento: California State Department of Industrial Relations, Division of Industrial Safety, 1965.

Tips (To Improve Personal Study Skills). Albany: Delmar Publishers, Inc., 1956.

In addition to the two publications listed above, the classroom library should include catalogs, brochures, installation manuals, and other descriptive and informational materials from manufacturers, fabricators, and distributors of products used in the glazing trade. The following list of such products includes suggested sources of information for each item:

Auto glass. Any parts book containing National Auto Glass Specifications; Windshield and Backlight Installation Manual, Libbey-Owens-Ford Glass Company; Automotive Curved Glass Installation Instructions, Pittsburgh Plate Glass Company

Cutting tools. C. R. Laurence Company (a division of L. H. Butcher Company); Red Devil Tools; Sommer and Maca Glass Machinery Company

Door closers. Dor-O-Matic; Jackson Exit Device Corporation; Rixson Closers

Fastening devices. C. R. Laurence Company; Sommer and Maca Company

Glass products. American Saint Gobain Corporation; Libbey-Owens Ford Glass Company (Glass for Construction and other publications); Mississippi Glass Company; Pittsburgh Plate Glass Company; other American glass manufacturers

Glazing sealants. Pittsburgh Plate Glass Company; Thiokol Chemical Corporation

Hand tools, including tools for auto glass installation. C. R. Laurence Company; Red Devil Tools; Sommer and Maca Company; Stanley Tools

Measurement and layout tools. Lufkin Rule Company; Stanley Tools; L. S. Starrett Company

Powder-actuated tool systems. Drive-it Powder-actuated Tools; Ramset Fastening System; Remington Arms Company, Incorporated

Power tools and machinery. C. R. Laurence Company; Henry G. Lange Machine Works, Incorporated; Milwaukee Electric Tool Corporation; Porter-Cable Machine Company; Sommer and Maca Company; Stanley Tools; Syntron Company

Sliding aluminum-frame doors. Air-Lite Metal Products; Kawneer Company; Pittsburgh Plate Glass Company

Store front metal, curtain wall systems, wall facings, and mirror frames. Kawneer Company; Northrop Architectural Systems; Pittsburgh Plate Glass Company; Rebco, Incorporated; Stylmark Company

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